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THE
HOME CRAFTS
HANDBOOK

THE HOME CRAFTS HANDBOOK

by

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BASKETRY AND RELATED ARTS SECTION

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FOREWORD

It is stimulating to see, within the covers of one book, so many different areas of Arts and Crafts covered so well. The authors of the different sections have gone to great pains to select projects that are well within the abilities of the average home craftsman and which will require of him a minimum of tools and specialized equipment. It is not even necessary to have a basement or an attic workshop for most of these projects although, of course, a specialized area that the home craftsman can call his own shop is the goal on which most home craftsmen have set their hearts.

Not only have the projects themselves been selected with care, but the instructional material for each project has also been worked out with equal care. The wealth of illustrations in the form of clean-cut line drawings and excellent photographs will make the instructions intelligible to anyone who will take the trouble to read them. The home craftsman who wishes to make the projects described in this volume will find that it is not necessary for him to have had formal instruction in this work before undertaking these projects. The book has been designed to meet the needs of the great mass of individuals in our country who have not had such formal instruction.

The book has also been designed to provide an outlet for the average American citizen who has always wanted to work with tools and materials but who, up to now, has never had much opportunity. The acquisition of a worthwhile hobby to be pursued during one's leisure time, has long been recognized for its many values. As the tempo of existence increases, it becomes all the more necessary that the man or woman who works under tension find some desirable way of relieving that tension. There is probably no better method of so doing than can be found in such creative activities as are described in this volume. There is probably no greater personal satisfaction from the use of one's leisure time than can be found in such creative pursuit. This book will open the doors to a whole new kingdom—one that can never be completely explored, one in which every new area that is opened up will offer limitless opportunities for future explorations. Happy indeed is the man or the woman, the boy or the girl, who has the chance to enter such a kingdom.

RALPH E. PICKETT,
Associate Dean.

Chairman, Department of Vocational Education
School of Education
New York University

PREFACE

The publication of the HOME CRAFTS HANDBOOK marks an era in the development of the craft courses at New York University. Many years ago when the craft courses were beginning, the need seemed to be for those courses which would give interested individuals experience in various crafts that could be used not only for teaching value but as a medium of expression during their leisure time. Dean Ralph E. Pickett, chairman of the vocational department, and I nursed these courses through their early development and about this time we obtained the services of Dr. John V. Adams to carry the load of actual instructing in these craft courses called Leisure Time Activities for Teachers. This course included many of the various crafts and we now offer these crafts as individual subjects in addition to continuing the course as originally started. As the courses progressed, it became necessary to obtain the services of people who through choice had specialized in these various crafts. Added sections in these craft courses required the services of still more instructors. The genesis of this publication can be found in the need for an organization of craft courses in such fashion as to make similar material available in all parallel courses in our craft shop. The skillful execution of the task as embodied in this book will make it apparent to all that the authors have accomplished their aims.

In explaining the various subjects, one of two methods has been chosen at the discretion of the authors. Each method has its individual advantages and equally successful teaching can be accomplished by either of the two. One method used is to explain the step-by-step procedure in the construction of the projects with references to and explanation of the techniques as the need arises. The other method used is to analyze the subject for its techniques and to teach first the techniques judged to be most important. The method of teaching by techniques is recognized by many authorities as that method best suited for teaching the fundamentals of shop processes. The teaching by use of the project method has more appeal to the layman but involves a careful arrangement of the teaching material. By choice, the subjects were selected by the authors as follows.

Dr. Robert L. Thompson, author of LEATHERCRAFT, has had many years of experience in teaching and organizing various shop and craft subjects. One of the country's foremost authorities on the industrial-arts gen-

eral shop, he has written LEATHERCRAFT in a live purposeful manner, choosing the project method for presenting the subject. Its immediate acceptance has proven its quality.

Dr. Raymond Van Tassel, author of WOODWORKING CRAFTS, presents his subject by the project method and with an understanding gained from his years of experience with craft and industrial arts schools and in associating with pupils and their problems. He has chosen projects in wood that cover the techniques of the field and hold the interest of the craftsman, thus dealing with an age old subject in a pleasing manner.

Mr. John G. Miller writes METAL ART CRAFTS with that attention to detail which is characteristic of all his work. A skilled craftsman and keen analyst it seems natural that he has chosen the analysis and technique method of presenting his subject. The inclusiveness and generous allowance of related information together with the projects described at the end of the section make this important part of craft work easy for those turning their attention to that field.

Mr. Louis L. Wiener, always the artist and skilled technician, has carefully analyzed his subject, HAND MADE JEWELRY, in a manner that guides easy teaching. He presents this subject by the analysis and technique method with chosen projects at the end of the section. The over-enrollment in his jewelry courses reflects his ability as a craftsman and teacher.

Mr. Désiré Kauffmann, a master craftsman in his chosen field, GRAPHIC ARTS CRAFTS, has injected a broadness of treatment growing out of his travels and varied experiences gained on two continents. He writes with the ease of an editor and covers the subjects completely, and rather beyond the ability of the average layman. He, too, has chosen the analysis and technique method of presenting his craft to produce a rare and unusually able presentation of the subject.

Dr. John V. Adams writes of the difficult field of plastics with that enthusiasm by which he laid the foundation for our craft courses at New York University in his many years of teaching and guidance. He has used both the project and the analysis and technique method of presenting this subject. As a pioneer in this new and interesting subject of PLASTIC ARTS CRAFT, Dr. Adams makes the construction of projects easy and enjoyable.

Miss Martha L. Lee is a skilled teacher and person of boundless energy. Her section on BASKETRY AND RELATED ARTS is characteristic of that inclusiveness that is necessary for a crafts instructor. The teaching by

subjects and the copious supply of assorted information give one a vast field for expression. The author has chosen the project method and although limited by space has included the essentials of the craft in an understanding manner.

With the increased recognition of shop work as a necessary experience for all persons, I believe the subjects as represented by the authors of the HOME CRAFTS HANDBOOK have helped to lay a sound cornerstone for the future of crafts. This particular type of experience is inclusive of many hitherto unrecognized advantages that will serve not only in the classroom but also in the home workshop.

May I congratulate the authors for their excellent work and may I point out that the marked and steady development of our craft and vocational activities is due to that guidance and reassuring leadership by the chairman of our department, Dean Ralph E. Pickett.

RAY E. HAINES,
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Director of Instructional Shops
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Leathercraft Section

BY

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INTRODUCTION TO LEATHERCRAFT SECTION

This section has been written for the beginning leathercraftsman. It is not a technical treatise of leatherwork. The home craftsman should have little difficulty in following the directions, and many enjoyable leisure-time hours may be spent in making worthwhile leather articles.

It will be noticed that there are no separate chapters on tools and materials, operations and processes. Each material, tool, operation or process has been introduced as the NEED for it arises. The leather projects, or articles to be made, progress from the simple to the more difficult. Therefore, the materials, tools, operations and processes introduced progress from the basic to the more specialized.

Each chapter is similar to a job sheet. Complete instructions for the making of a leather project are given in each chapter. The reader will notice that each succeeding chapter presents only NEW operations processes, tools, and materials. Frequent references are made to processes which must be repeated. Therefore, each operation and illustration has been numbered accumulatively throughout the section.

The primary objective of this section is to present fundamental leather handicraft activities in a clear and practical manner. The actions have been well illustrated and carefully grouped in sequential order to provide explicit directions for the step-by-step manufacture of a typical leather article. No attempt was made to list projects and designs. It is the author's belief that the individual readers' taste and diversified interests are too varied to be even partly satisfied in a book of this type. Patterns of leather articles and various designs may be obtained from a number of sources too numerous to mention.

I. LEATHERCRAFT SECTION

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Chapter I

HOW TO MAKE A LEATHER BOOKMARK

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Chapter II

HOW TO MAKE A LEATHER KEYCASE

•

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HOW TO MAKE PURSES AND HANDBAGS

•

Chapter VII

HOW TO MAKE A CARVED LEATHER KNIFE SHEATH

Chapter VIII
HOW TO MAKE BRAIDED AND LINK BELTS

Chapter IX
HOW TO MAKE A BRAIDED LANYARD

Chapter I

HOW TO MAKE A LEATHER BOOKMARK

A leather bookmark is an ideal project for the beginning leather craftsman. Very little material is involved and basic operations and processes are introduced. The size and shape of the project can vary with the craftsman's taste.

1. Select a design which is suitable for the size and shape of your bookmark.

The design should be fairly simple with large flowing curves and straight

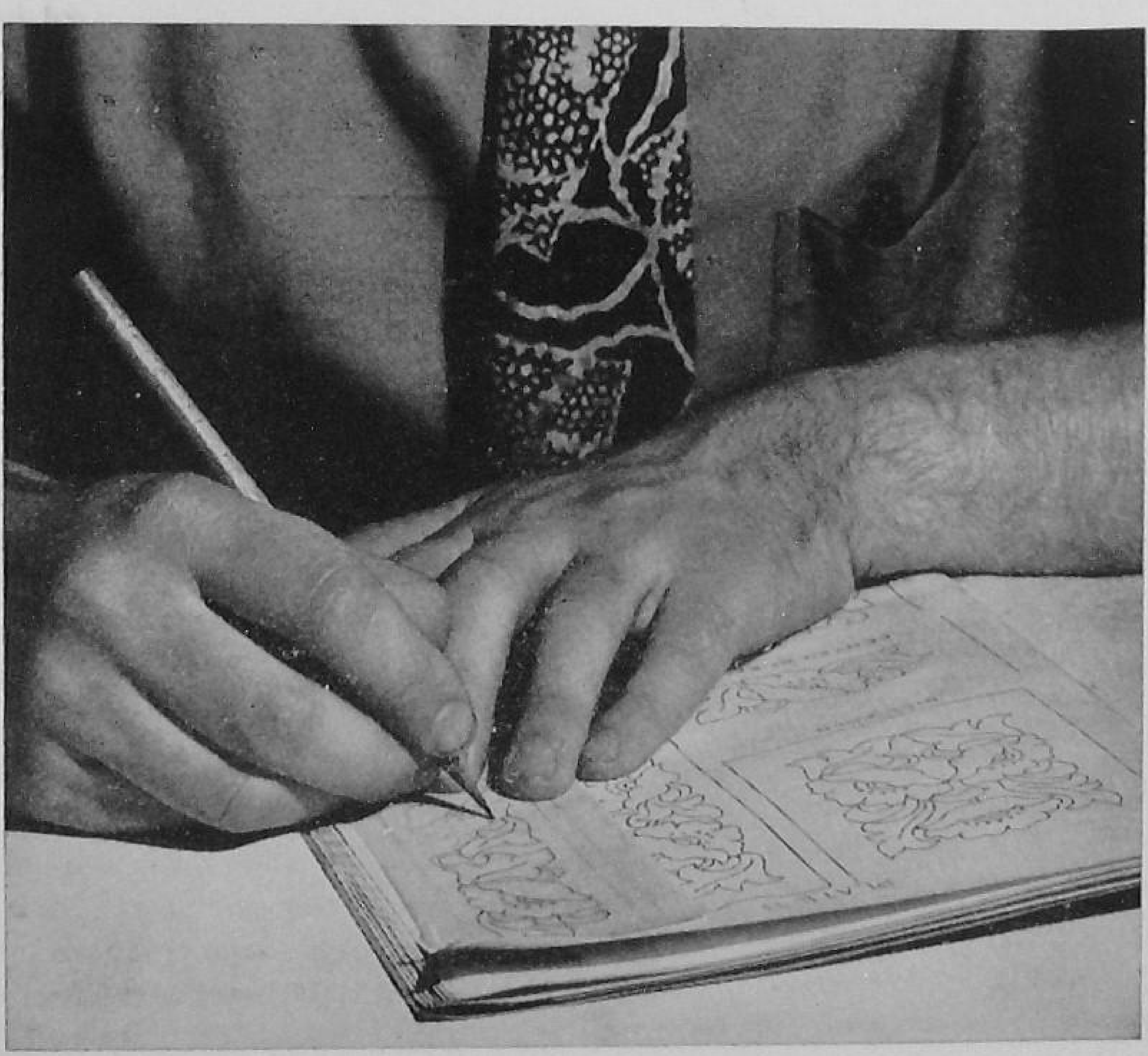


Fig. 1.

lines. An elaborate design with very small curves, circles, and sharp angular corners is difficult for the novice to tool.

2. Trace design.

Place a piece of tracing paper (transparent paper) over the design and with a sharp pencil trace the design as shown in Fig. 1. The tracing should be made as accurately as possible since in transferring the design to the leather any irregularities which appear on the tracing paper might also be traced on the leather.

3. Cut leather to desired dimensions.

Leather may be purchased in whole, half, or quarter skins. Tooling calfskins average approximately 9 to 12 square feet per skin and between 4 to 6 square feet for a half skin.

There are various methods of cutting leather projects from the whole skin. Some leathercraftsmen use sheet metal templates (18 gage or heavier) or cardboard patterns for all projects. Others lay-out the dimensions directly on the leather with a scriber. This latter method may be used to cut out the leather bookmark from the skin.

Lay the skin, with the grain or finished side up, on a large wooden surface. Using a straight edge, preferably a framing square or a yard stick, lay it along one of the irregular edges of the skin as shown by the dash line in the sketch, Fig. 2. Place a sharp knife alongside the straight edge and at one end of the skin. Hold with one hand and draw the knife toward you slowly. Make sure that the knife is always against the straight edge and use enough pressure on the knife to cut through the leather and into the wood. If possible, make the cut across the grain of the wood. If the cut is made parallel to the grain of the wood, the knife may have a tendency to follow the grain and an irregular cut will result. A good cutting board can be made from a large piece of pressed wood and a cut can be made without reference to grain. The leather should be cut with one stroke. Going over a cut twice almost always leaves a ragged edge.

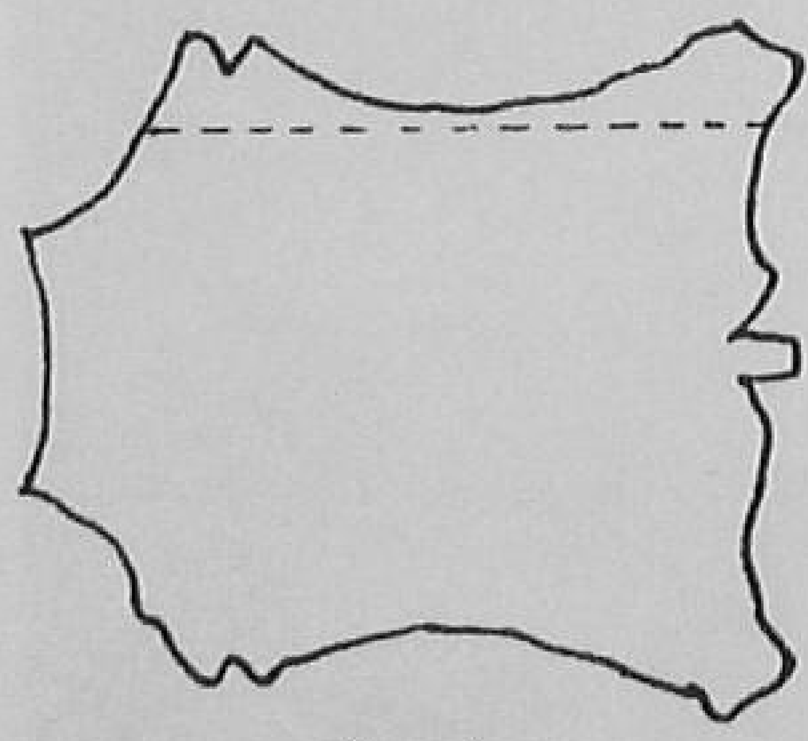


FIG. 2.

Using a steel scale or square and a scriber, lay out the dimensions from the straight edge of the skin. Cut out the bookmark as shown in Fig. 3.

Make sure that your fingers are well out of the path of the cutting knife and be careful not to cut beyond the layout points and into the rest of the leather skin as this would ruin leather for further layouts.

4. Moisten the leather bookmark.

Lay the leather bookmark with the flesh or unfinished side up. Dip a clean cloth pad or sponge into cold water. Squeeze out excess water and rub or pat the surface of the leather with the moistened cloth as shown in

FIG. 3.

Fig. 4. Always dampen the entire surface of the leather as this will eliminate any noticable color change on the grain or finished side of the leather and shrinkage will be more uniform.

Do not moisten the leather too much as it will penetrate to the grain side and discolor the leather. It is best to dampen the leather only slightly for

tracing. Dampened leather is very pliable and will take any slight impression. Care should be taken not to touch it with the fingernails, rings or bracelets and do not lay it on an uneven surface.

5. Trace design on leather bookmark.

Place the tracing on the grain side of the leather, making sure that it is centered and in the correct location. The edges of the tracing paper may

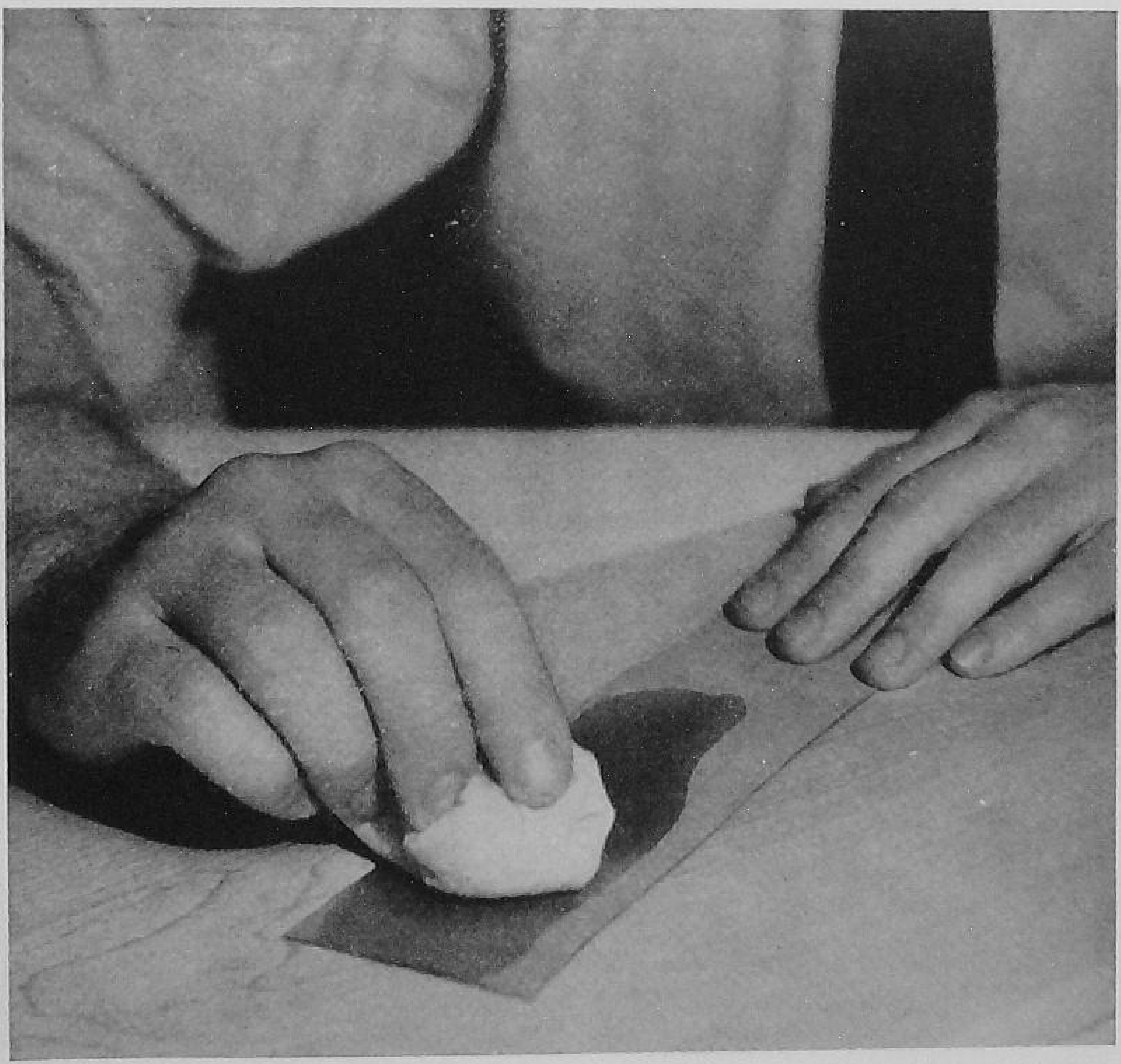


FIG. 4.

be folded under the leather to keep it from slipping or small pieces of Scotch tape can be used to fasten the design to the leather. It is important, however, that the tape should not touch the grain surface of the leather. Do not use paper clips as they might mark the leather. Lay the dampened leather bookmark, grain side up, on a piece of plate glass or marble. It is

advisable to trace upon a scrap piece of the leather being used before proceeding with the actual project.

Carefully trace the design with a tracing tool as shown in Fig. 5. The tracing tool has a rounded end so it will not cut through the paper. Use just enough pressure to make a clear line on the leather. In order to make sure of the pressure and to see if all lines are being traced, raise a section

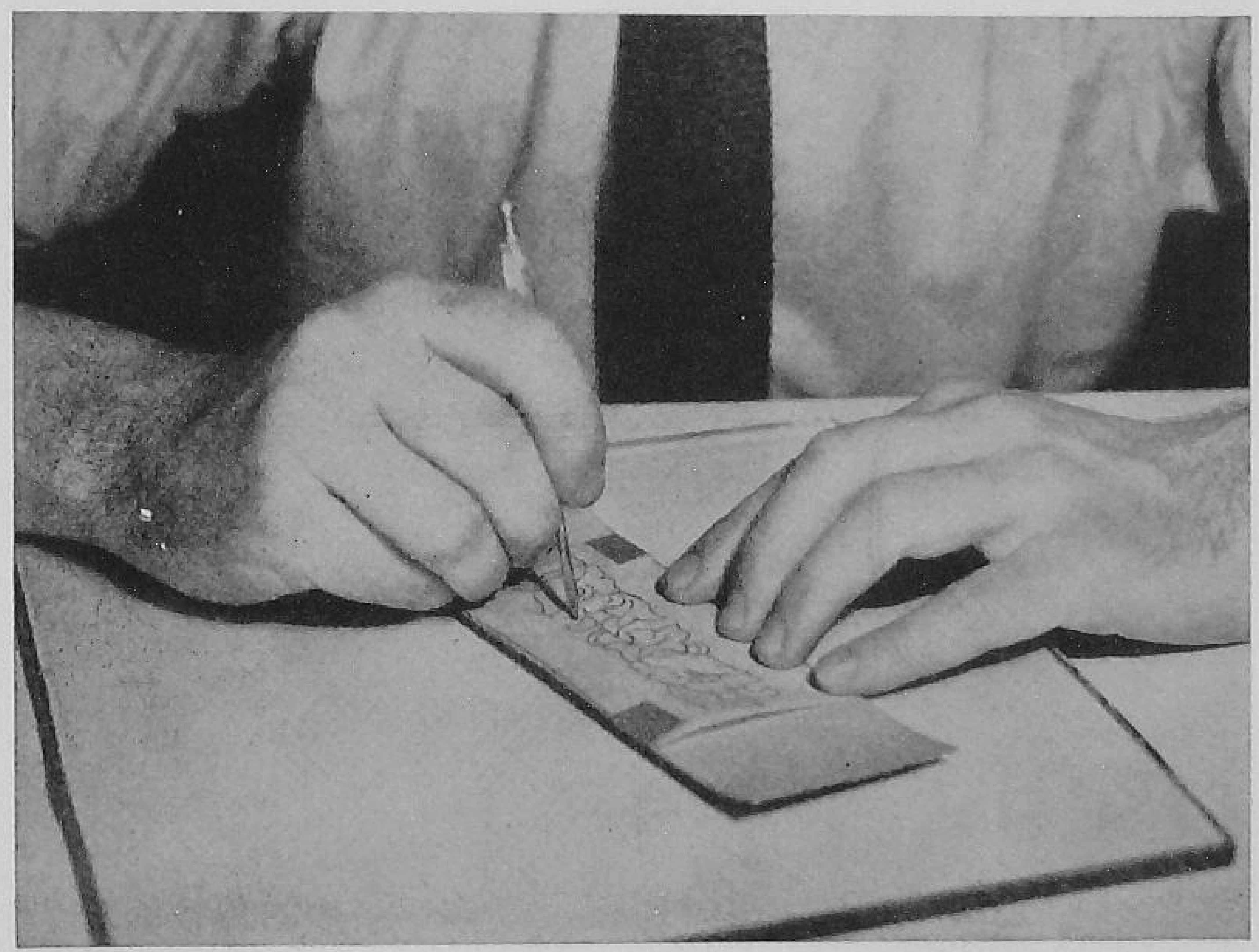


FIG. 5.

of the tracing and examine your work. Be very careful when tracing as any lines incorrectly traced are almost impossible to remove from the leather.

Some leathercraftsmen use carbon paper and transfer the design from the tracing paper to wrapping paper. They are thus enabled to apply a greater pressure on the tracing tool when transferring the design from the wrapping paper to the leather. There are some tooling leathers which need no moistening for tracing.

6. Dampen leather for tooling.

Remove the tracing paper. Again dampen the leather until it contains

the correct amount of moisture for tooling. This can be determined in general by the appearance of the tooled surface. When the conditions for tooling are correct, the color of the leather in the depressed areas will turn to a darker shade and the tooled line will be uniform and permanent. If too much moisture is present the surface will be soggy and any pressure on the

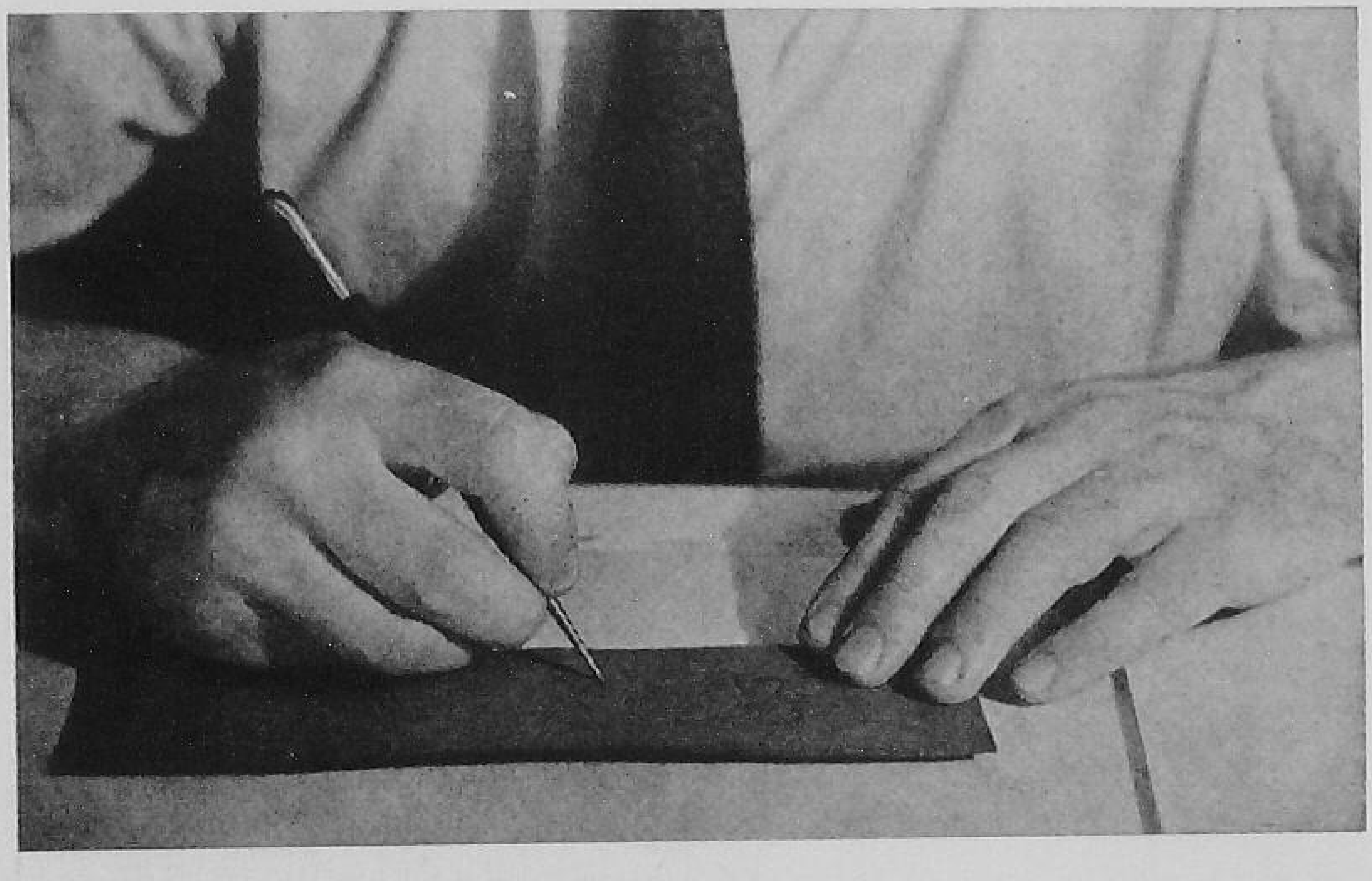


Fig. 6.

finished side will produce surface water. As the moisture necessary varies greatly with the kind and thickness of the leather, no definite rules for the amount of moisture can be given.

7. Tool design in leather bookmark.

With the curved point of the Spade or Spoon modeler, tool or deepen the lines of the design into the dampened leather as shown in Fig. 6. This type modeling tool has a curved point on one end and the other end shaped somewhat like a spoon. Hold the modeling tool at the same angle you would a lead pencil and place the rounded part of the pointed end on the design. Draw the tool toward you using considerable pressure. The leather may be turned with one hand and the tool swerved between the fingers of the other hand when tooling curved lines. Hold the tool in a more upright position when working around a projecting point in the design. Tool all

straight lines using a straight edge as a guide. When approachng a square corner in the design, turn the leather around and push the tool to the corner. If the tool is pulled to the corner, the curved end of the tool may overrun the design and crossed lines will result. Do not tip the tool too far forward on the push stroke as it will dig into the leather. Go over the design several times until it is tooled well into the leather book mark.

8. Stipple the background of the design.

Stippling is a form of background tooling which depresses the background and leaves the design standing out in contrast. Stippling may be

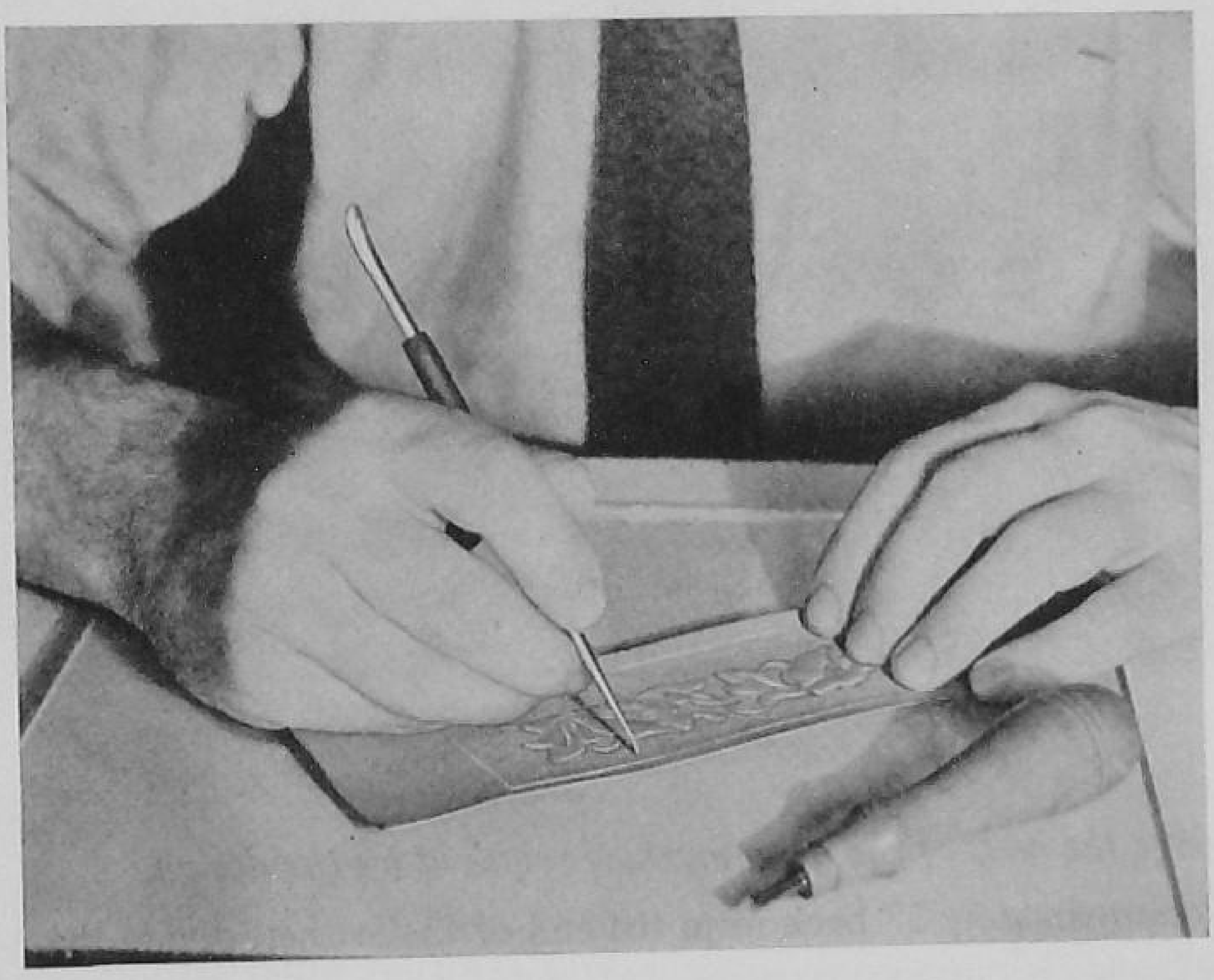


Fig. 7.

done with any blunt pointed tool. A stippling tool (see Fig. 7) with six or seven points may be used but the operation can be completed with the tracing tool or the rounded pointed end of the Spoon End modeling tool.

Stippling is accomplished by tapping the background of the design as shown in Fig. 7. Use enough pressure to make depressions in the leather but do not use such excessive pressure that the tool will break through the leather to the flesh side. The depressions should all touch each other and the background should have a uniformly roughened surface. Be careful,

when stippling near the tooled lines, that the tool does not strike the design. When the stippling is completed, it is advisable to lightly retool the design.

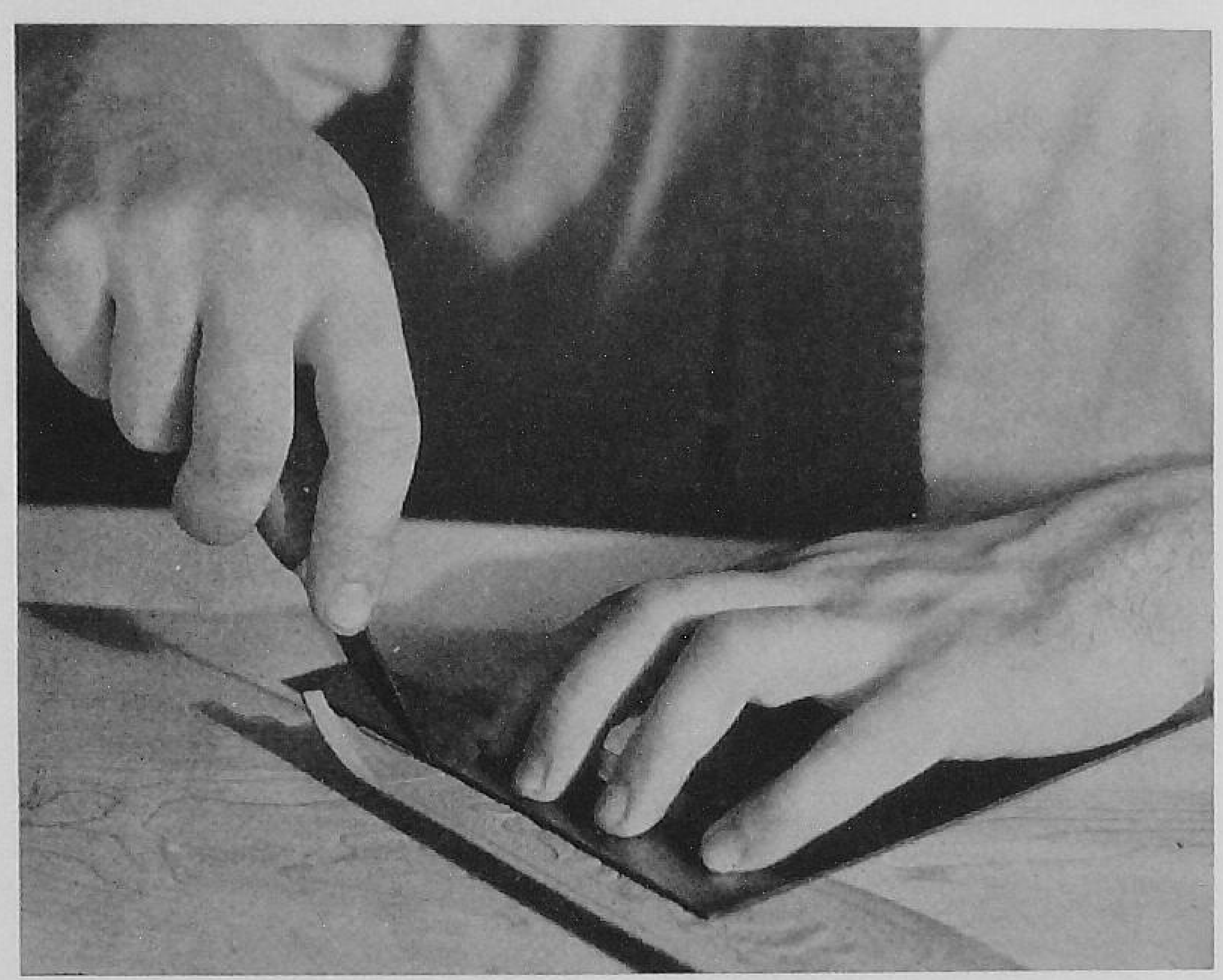


FIG. 8.

9. Fringe the ends of the book mark, if required by the design.

At approximately 2″ back from the end of the leather, divide the width of the bookmark into even spaces, ⅛″ to ¼″ wide, using the pointed end of the modeling tool and a straight edge. Place the leather on the cutting board and with a sharp knife and straight edge, fringe the ends as shown in Fig. 8.

10. Stain edges of bookmark.

With a corresponding or contrasting leather dye and a striping brush, stain all cut edges of the leather. Use the side of the bristles to prevent dye from running off the edge onto the surface, and be sure that the tip of the brush protrudes toward the flesh side. See Fig. 9.

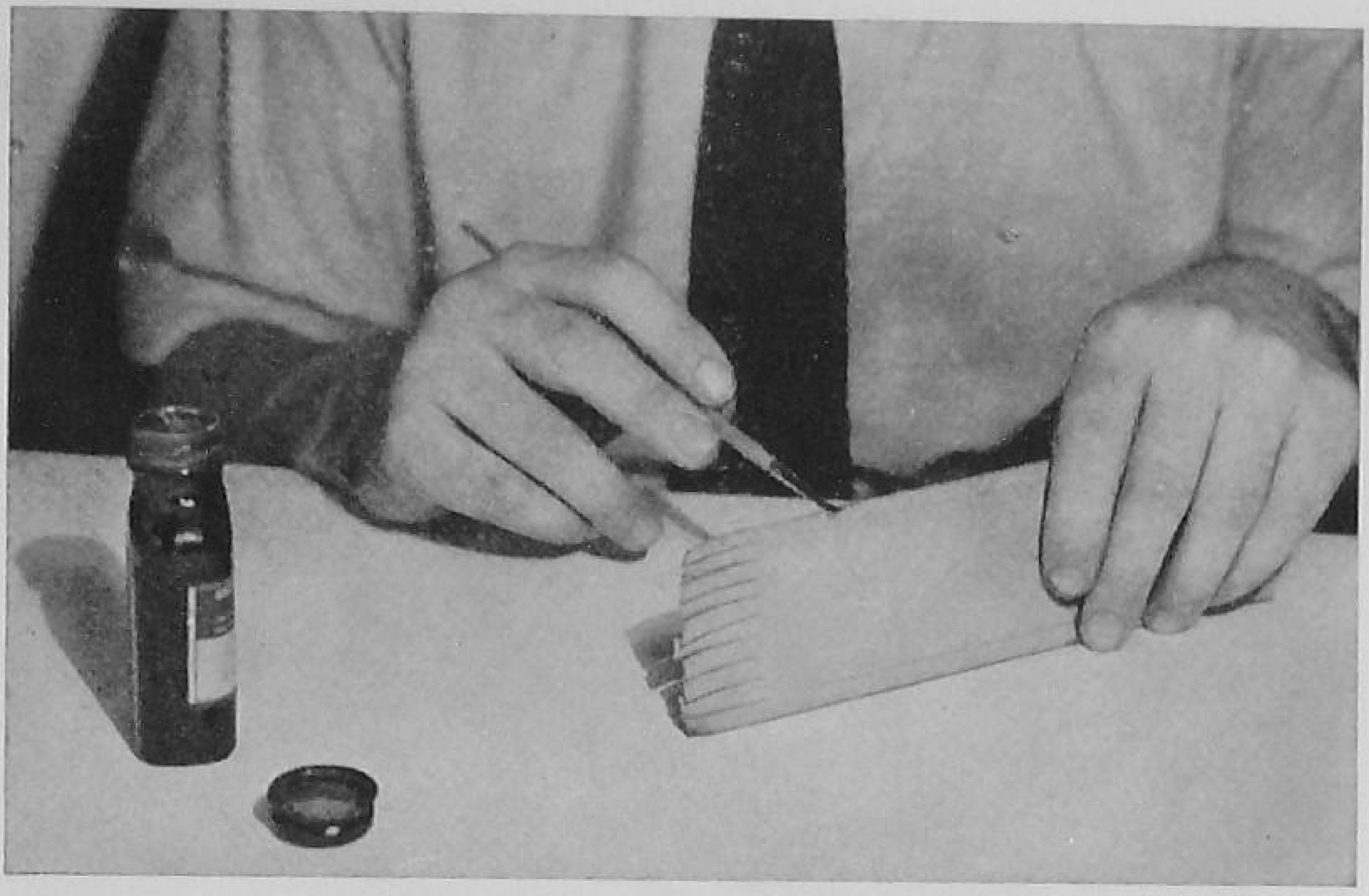


FIG. 9.

11. Crease the edge of the leather bookmark.

The Metal Edge Creaser provides a means of adding a professional touch to leatherwork by making a depressed line along the edge of the leather and eliminating any tiny fibers present from the cutting. The end of the tool is composed of two highly polished crescent shaped projections, one longer than the other (see Fig. 10). Place the tool on the edge of the leather with the longer leg resting against the edge of the leather and the shorter leg resting on the surface of the leather. Draw the creaser back and forth along the edge of the leather with a steady firm pressure as shown in Fig. 11. Many leather craftsmen heat the tool in a clean flame to approximately the heat of a flat iron. The heated tool gives a burnished effect to the edge of the leather.

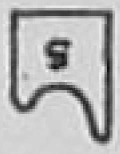


FIG. 10.

12. Clean bookmark with saddle soap.

Dampen a cloth and apply a small amount of saddle-soap lather to the finished surface of the leather bookmark. Allow it to dry for several minutes and polish with a dry, soft cloth pad (see Fig. 12).

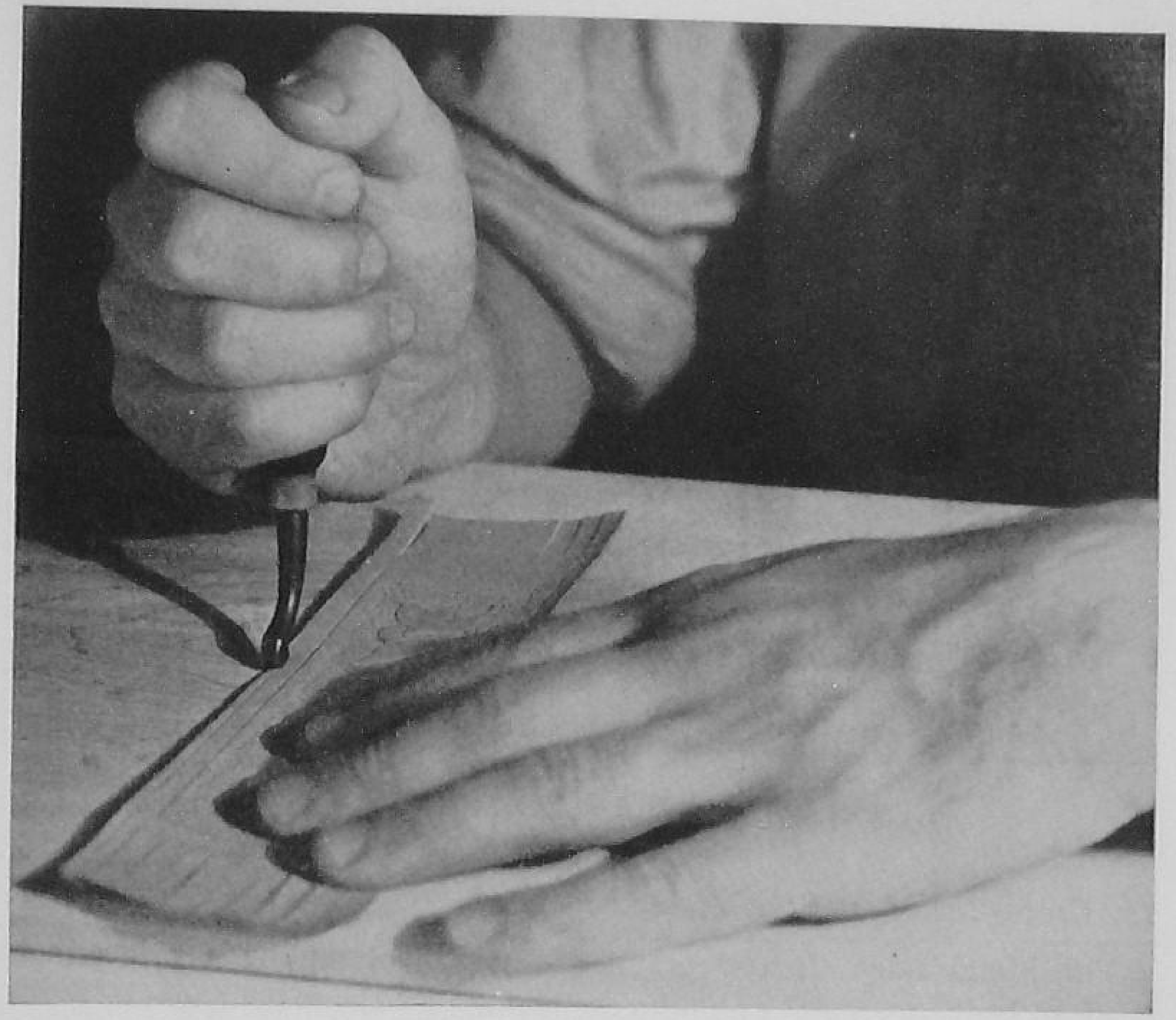


FIG. 11.

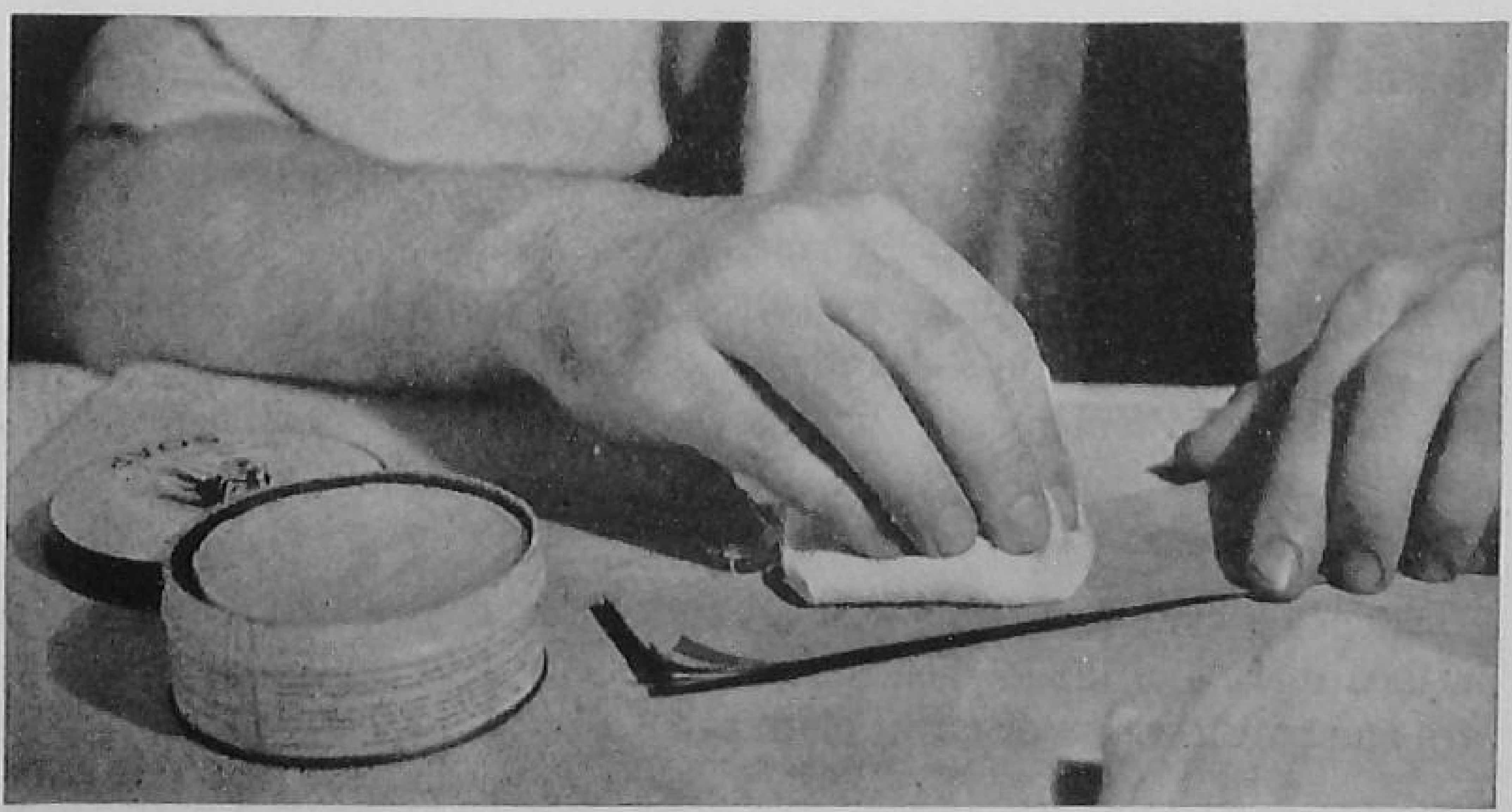
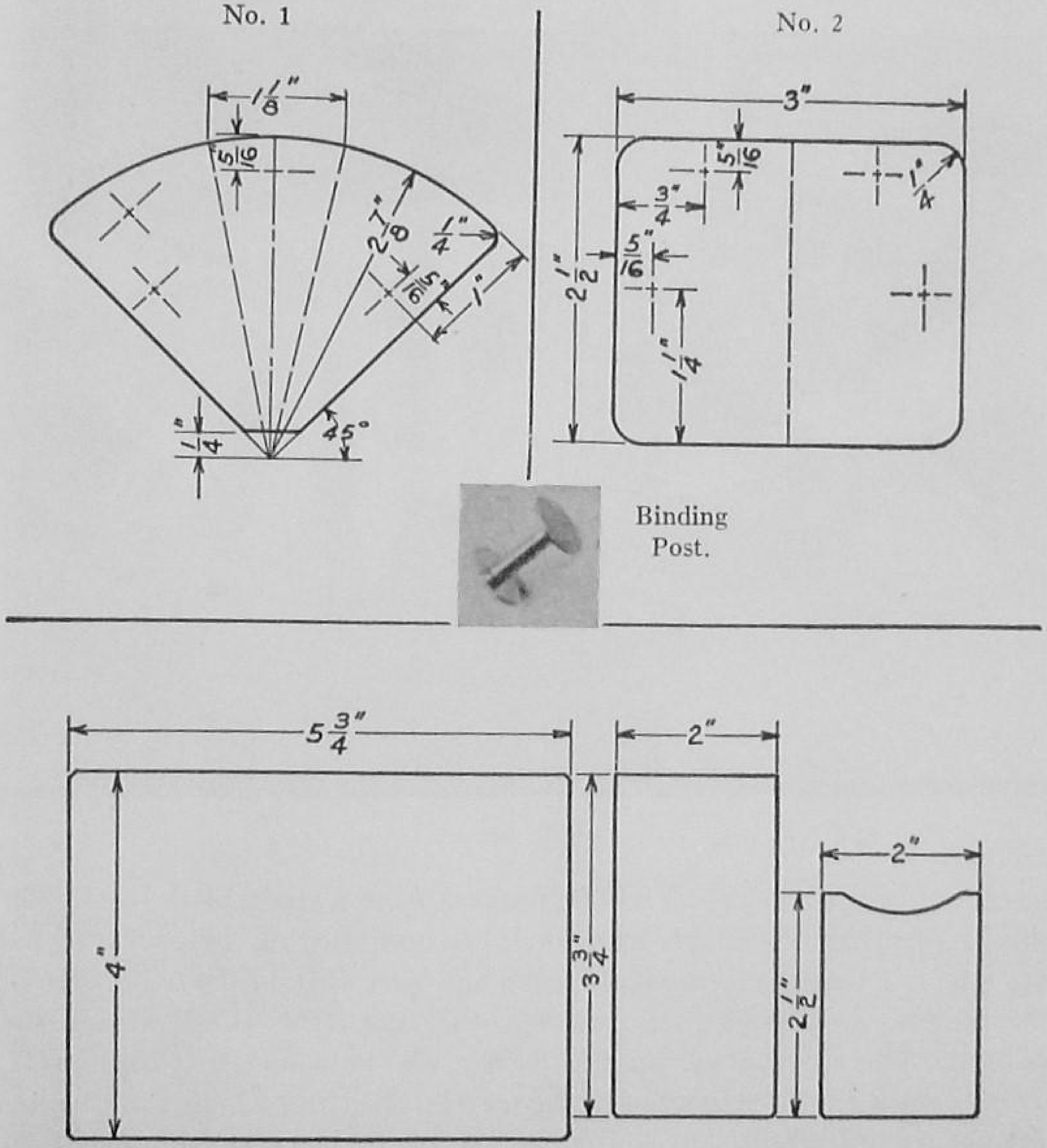


FIG. 12.

Chapter II

HOW TO MAKE A LEATHER KEYCASE



No. 3

Fig. 13.

The keycase is a popular leather project. A minimum of material is involved and a large number of fundamental operations and processes, in addition to the ones decribed in Chapter I, are introduced. The size

and shape, as well as the design used, can vary with the craftsman's taste. Three suggested types of keycases are shown in Fig. 13. If it is necessary to teach or learn a minimum amount of leatherwork in a very short period of time, the keycase dimensioned in No. 3, Fig. 13, is the ideal project upon which to work. In addition to the many basic leather operations and processes which go into its manufacture, it also can be laced with two dif-

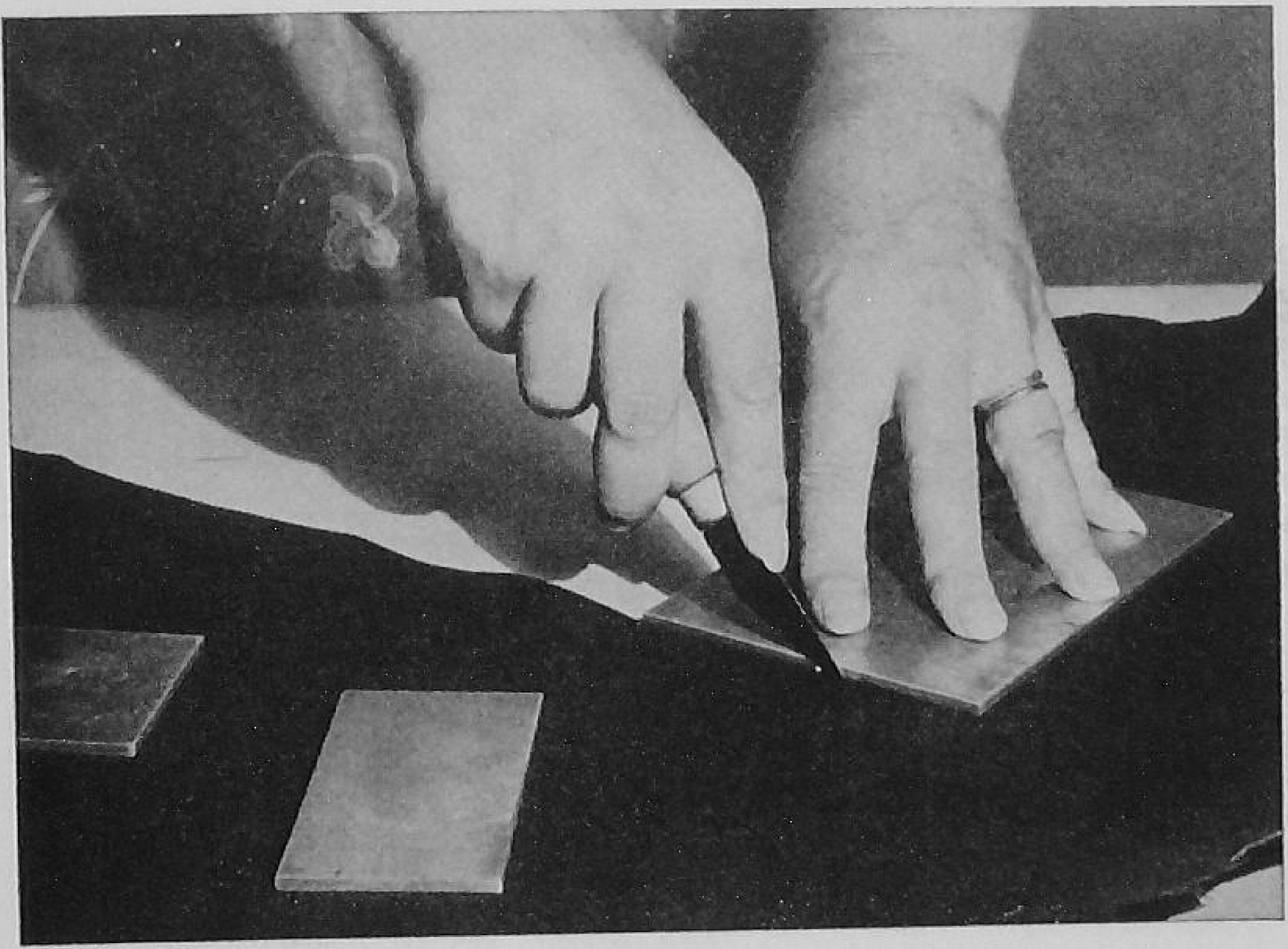


Fig. 14.

ferent methods of lacing. It will be noticed, from a study of the figures in this chapter, that the double-loop stitch has been used on the pocket of the keycase, and that the button-hole stitch has been used on the outer edge of the project. In this chapter, however, only the latter stitch will be explained. The explanation for the former will be found in Chapter III. Furthermore, the large piece of leather can be lined as explained in Chapter III and, if natural calfskin is used instead of the black calfskin shown, it may be tooled and stained as explained in Chapter V.

13. *Select a suitable design* (see Step 1, Chapter I).
14. *Trace design* (see Step 2, Chapter I).
15. *Make metal template for leather keycase* (No. 3, Fig. 13).

Templates are usually permanent patterns which have been cut out of fairly heavy sheet metal (generally 18 gage galvanized steel or brass). They are extremely useful for class work where project sizes do not vary to any great extent.

Using the dimensions given, lay out the pattern on the metal. Cut carefully around the pattern lines with tin snips and smooth the edges with a file and steel wool. All templates should be labeled. They may be numbered with black enamel, or they may be lettered with steel letter stamps. It will be necessary to make three templates for this project.

16. Cut leather to desired dimensions.

This may be done as explained in Step 3, Chapter I, or by the use of the templates just described.

Place the leather flesh side down on a cutting board. Lay the largest of the three metal templates near one edge of the leather. Place a sharp knife at one inside corner of the metal template and, using the edge of the metal as a straight edge, cut the leather to the desired shape as shown in Fig. 14. Be sure to cut the leather entirely through with one stroke. Do not ruin a whole skin by placing the template in the center of the skin and do not allow the knife to cut beyond the limits of the template as the remaining skin will be ruined or wasted.

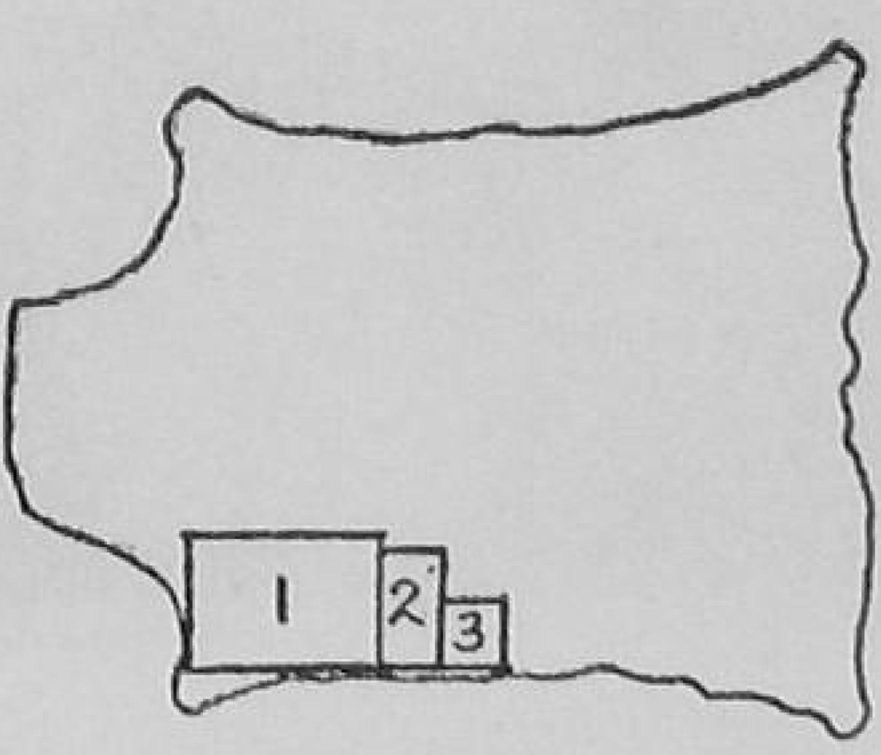


FIG. 15.

Place the medium-sized template on the leather with the longest edge of the template flush with one of the previously made straight cuts (see Fig. 15). Cut the leather to the desired shape. Repeat the operation with the smallest of the three templates. Concave, convex, and irregular curves may be cut with a pair of shears or scissors.

17. Moisten the leather (see Step 4, Chapter I).

18. Trace design on keycase (see Step 5, Chapter I).

19. Dampen leather for tooling (see Step 6, Chapter I).

20. Bring the design into relief by "beveling."

Beveling is another form of tooling which brings the design into relief. In this type of tooling, the spoon end of the modeling tool (see Fig. 6) is used instead of the curved point.

Hold the tool in the right hand at approximately a 45 degree angle to the leather. Place the tip of the spoon end of the modeling tool on the outside edge of the design. Exert a downward pressure on the tool and move it sidewise, following the lines of the design as shown in Fig. 16. To assure a uniform and steady stroke, place the index finger of the left hand near the end of the tool and exert a pressure in exactly the opposite direction to that in which the tool is being moved by the right hand. For good control, the backward pressure exerted by the left index finger should be slightly

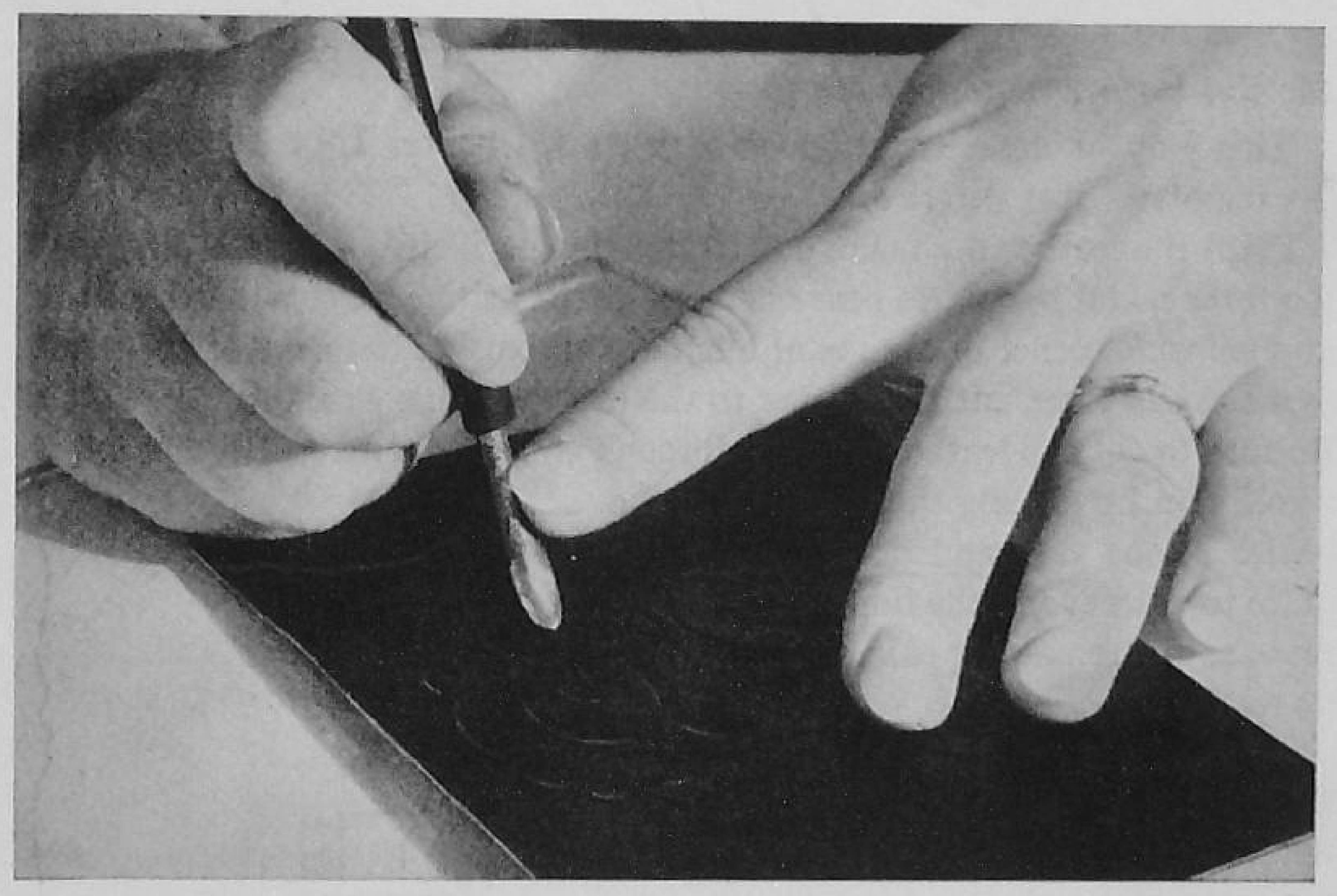


FIG. 16.

less than the forward pressure of the right hand. The other three fingers of the left hand are used to keep the leather from moving or slipping.

The shape of the slanting spoon end automatically does the beveling and the resulting inclined line should be clear and sharp at the edge of the design.

Hold the tool in a more upright position and twist or swing the tool between the fingers when working around sharp corners, angles, and curves. When the bevels meet, an uneven ridge is formed. This can be removed by moving the tool lightly back and forth. The beginner should practice this form of tooling on a scrap piece of leather before beveling the design of the leather keycase.

Some leathercraftsmen tool the design with the curved point of the modeling tool, as explained in Step 7, Chapter I, before beveling.

21. Lay out center line of lacing holes.

Using a steel scale and a scriber, place a *light* point 3/16″ in from each corner. This should be measured at the corners of the leather and the mark should be placed on or near each edge. Connect two opposite points

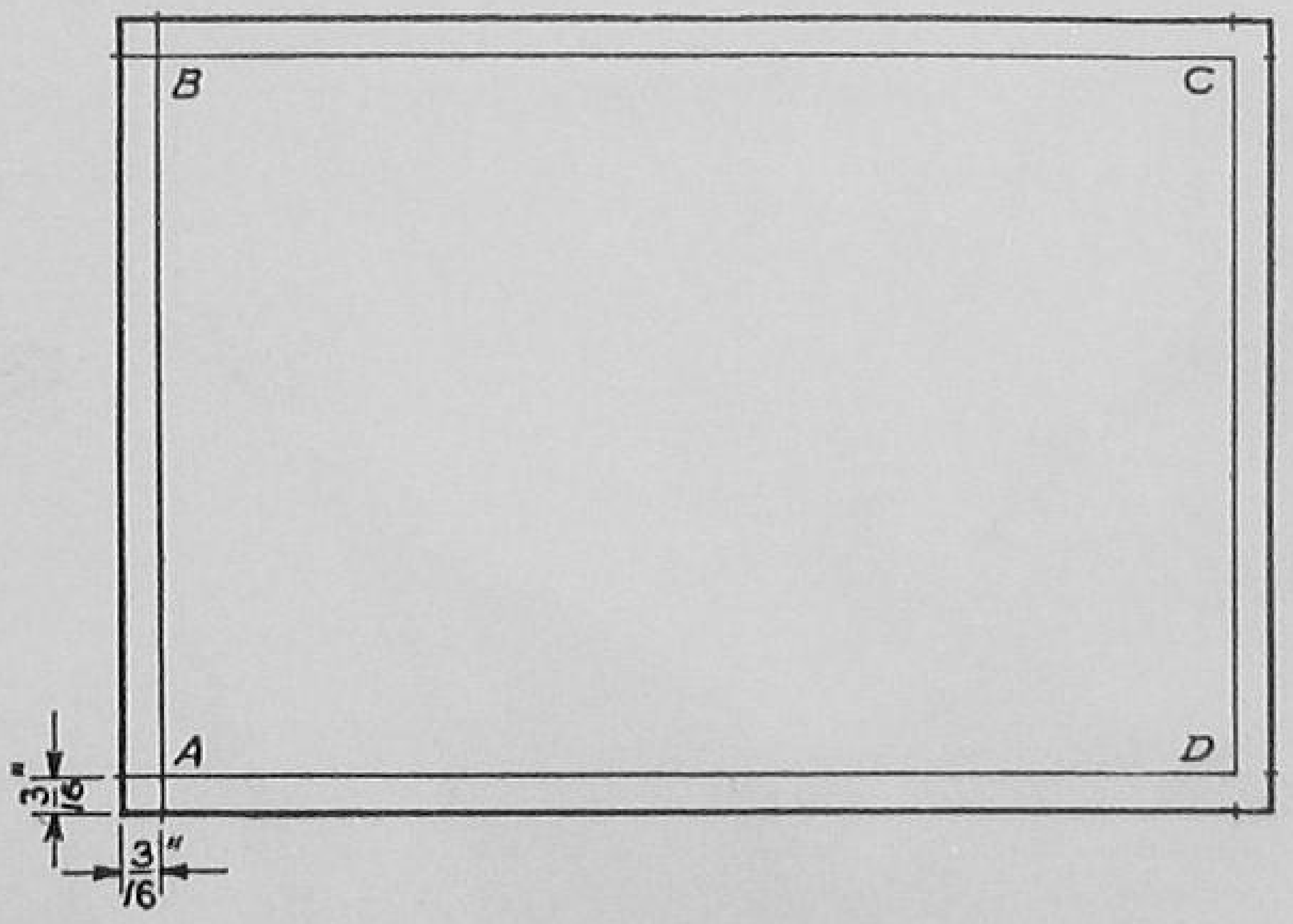


Fig. 17.

with a straight edge and tool a light line from corner to corner. The center lines should not cross each other as at *A* and *B*, but should begin and stop 3/16″ in from each edge as shown at *C* and *D*, Fig. 17. The above layout should be made on the largest piece of leather. As the smallest piece of leather is to be used as a pocket, it should have center lines on the two long edges and on only one of the short edges.

22. Lay out center points of lacing holes on center lines.

Lay a straight edge alongside one of the center lines. Place the spacing wheel against the straight edge with one of the points of the wheel on the corner of the center lines. Exert a slight downward pressure on the spacing wheel and run the tool forward to the opposite center-line corner as shown in Fig. 18. The saw-toothed edge of the wheel uniformly marks the location of each lacing hole to be punched. Spacing wheels may be obtained which will mark 5, 6 and 7 spaces to the inch. There are three factors

which determine the distance between the lacing holes. The number of layers of leather being joined, the thickness of the leather, and the size of the lacing. A good general rule to follow is to have the center distances of the punched holes equal to the distance from the edge.

As all leather projects have different dimensions, the marks made along

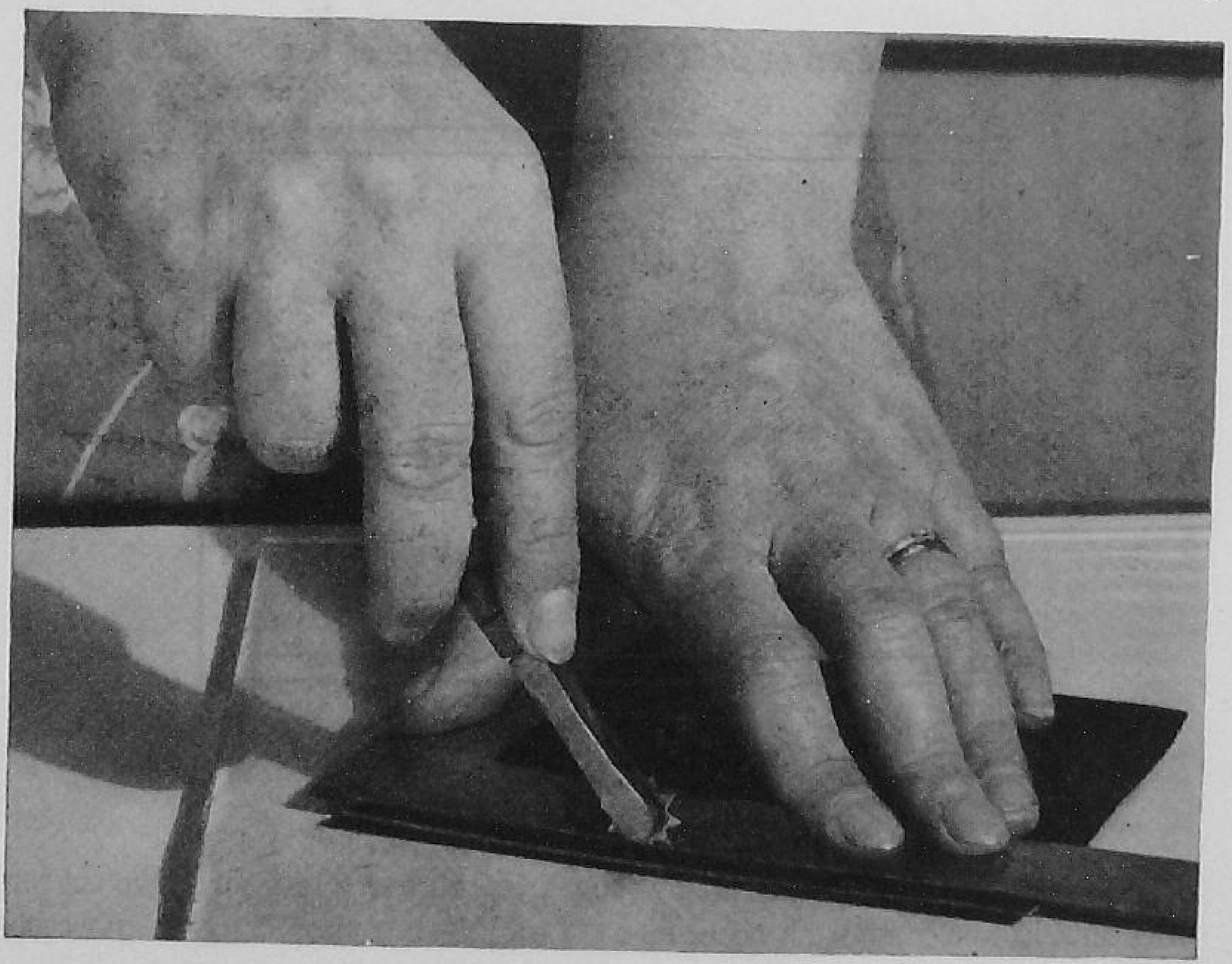


FIG. 18.

a center line may not come out evenly. In this case, stop the wheel three or four spaces from the corner. Using a scriber, space the remaining distance by eye.

23. Punch the lacing holes.

When punching lacing holes in a leather project it is advisable to assemble all the pieces and temporarily fasten them together with a small amount of leather cement or masking tape. Punch each hole through the various thicknesses of leather at one time. This will permit the accurate alignment of the punched holes in the various pieces which are to be laced together.

Place a little leather cement on the flesh side of the two upper corners of the medium-sized (see No. 2, Fig. 15) piece of leather. Superimpose it on the flesh side of the large piece (see No. 1, Fig. 15) of leather and cement it so the top edge of the medium-sized piece is flush with the top edge of the large piece and centered. Fasten the small piece (see No. 3, Fig. 15)

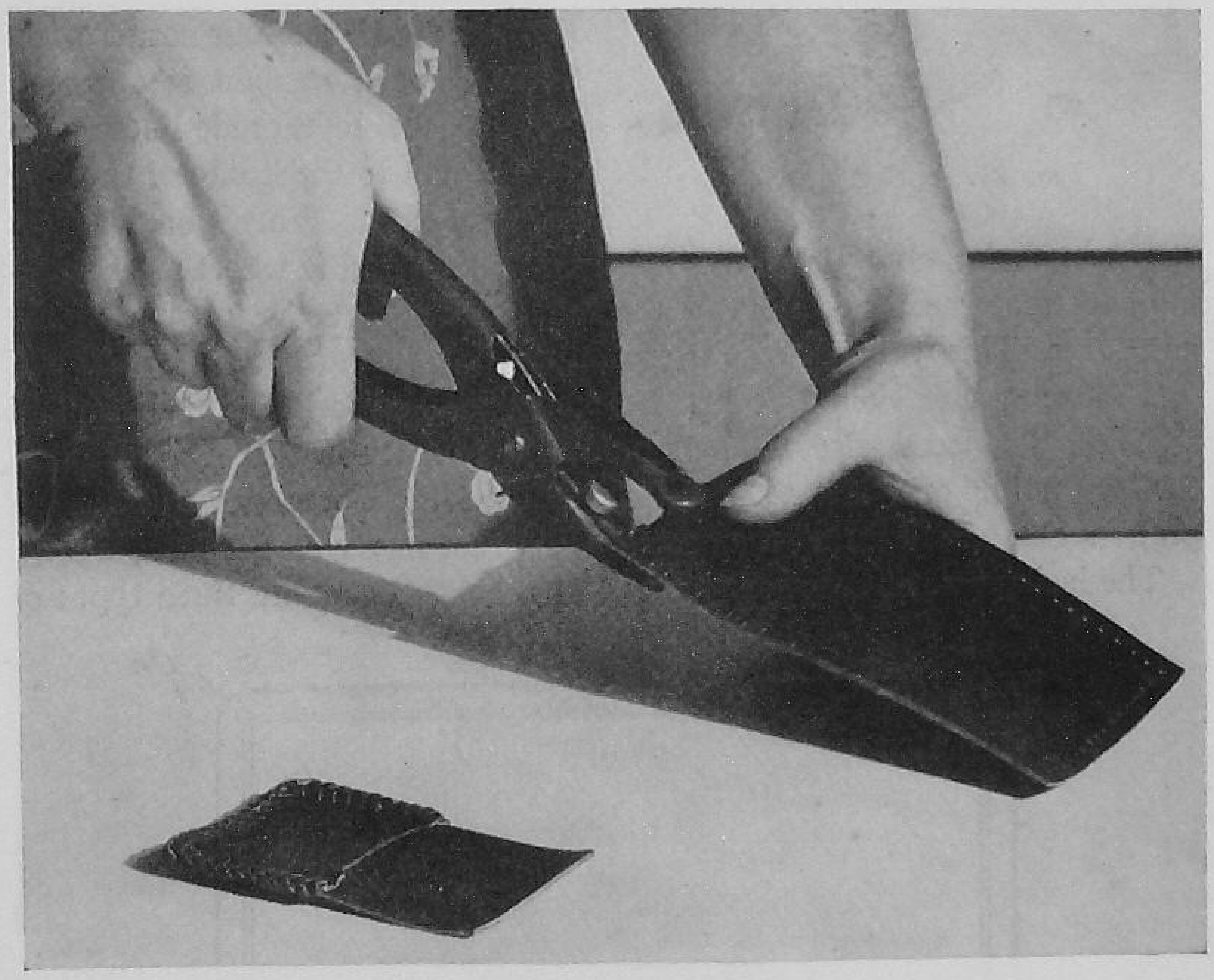


Fig. 19.

in a similar manner to the bottom of the medium-sized piece. The last two are shown partly punched and laced in Fig. 19.

Using a Five in One Punch (see Fig. 20), adjust the gage which is between the jaws so the holes will be punched exactly 3/16″ in from the edge of the leather. See chart showing punch tube sizes at bottom

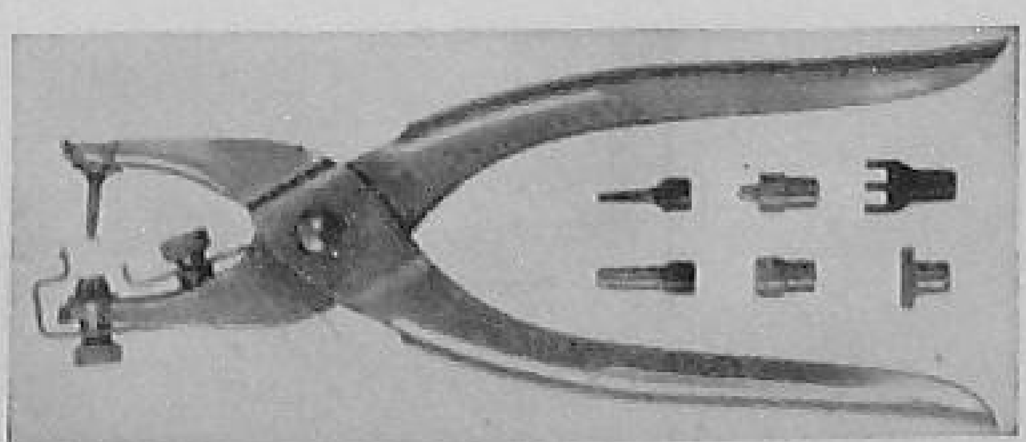


Fig. 20.

Five in one punch. Punches holes, sets eyelets, slits holes for flat lacing, gages the distance from the edge, and spaces the holes properly.

of page 72. Punch all holes marked (see Fig. 19). A cleaner hole will be made if a piece of cardboard is held under the leather to punch into. This also saves the brass plate of the punch from becoming worn or pitted.

FIG. 21. Spring punch.

If a single tube spring punch (see Fig. 21) is used, it is advisable to make a further layout as shown in Fig. 22. Punch the four corner holes first. Using a straight edge and a modeler, tool light guide lines which are tangent to the inside of the four holes punched. When punching the remaining holes, close the punch lightly over the spacing wheel mark making sure that the inside edge of the round punch tube is tangent to the guide line. This will assure an even and uniform row of holes.

The lacing hole should be just large enough for the lacing to be pulled through. The laced edge will look much better if the leather closes around the lace and no open space shows through the hole. Some leathercraftsmen prefer a narrow slit rather than a round hole for receiving the lace.

The lacing awl makes a slit instead of a hole. There are three types of

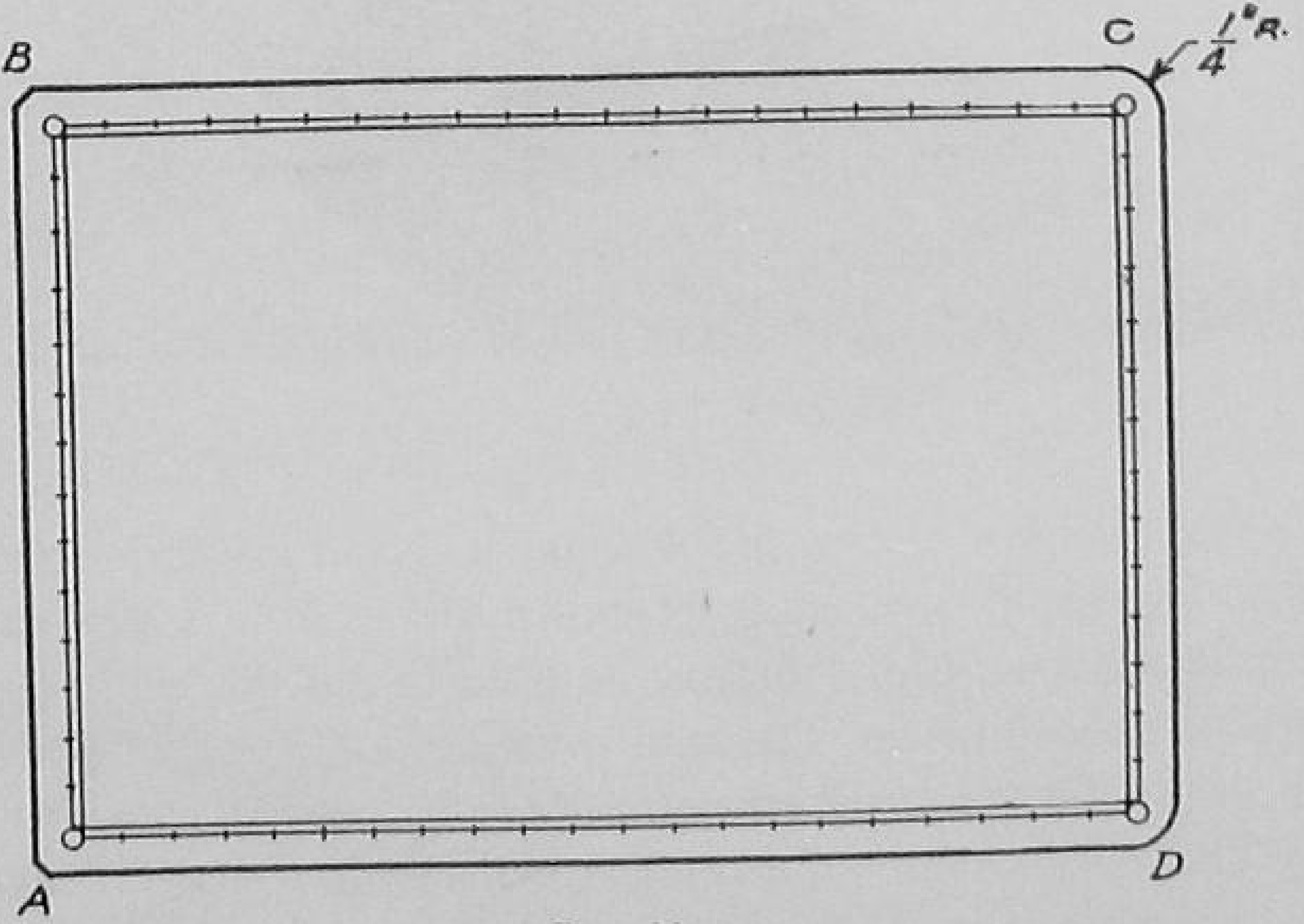


FIG. 22

lacing awls or thronging awl. The four-prong, three-prong, and single-prong. The four- and three-pronged awls are used for punching slits on straight edges and the single-pronged awl is used on curves and corners. The slits made are generally for $\frac{3}{32}$″ lace.

If it is desired to use the lacing awl rather than the spring punch, lay the leather flesh side down on a piece of hard wood and lay out the center lines for the slits as described in Step 21. With a single-pronged awl, punch the corner holes as shown in Fig. 23. The corner slit should be placed at a 45

FIG. 23.

degree angle. With a four-pronged lacing awl and a wooden mallet, punch the slits along the straight edges as shown in Fig. 24. A steel lacing needle with a split end (see Fig. 25) may be used to aid the leathercraftsman in inserting the lace into the slit, and drawing it through. The end of the lacing is gripped by the split end of the needle and is not threaded through an eye. This permits only one thickness of lacing to pass through the slit.

24. Fasten key plate to medium-sized piece of leather (see No. 2, Fig. 15).

Key plates are generally manufactured from the finest tempered steel and may be purchased with from two to eight hooks. The key plates may be fastened to the leather before or after the project has been laced. The key plate shown in Fig. 26, however, should be fastened to the keycase

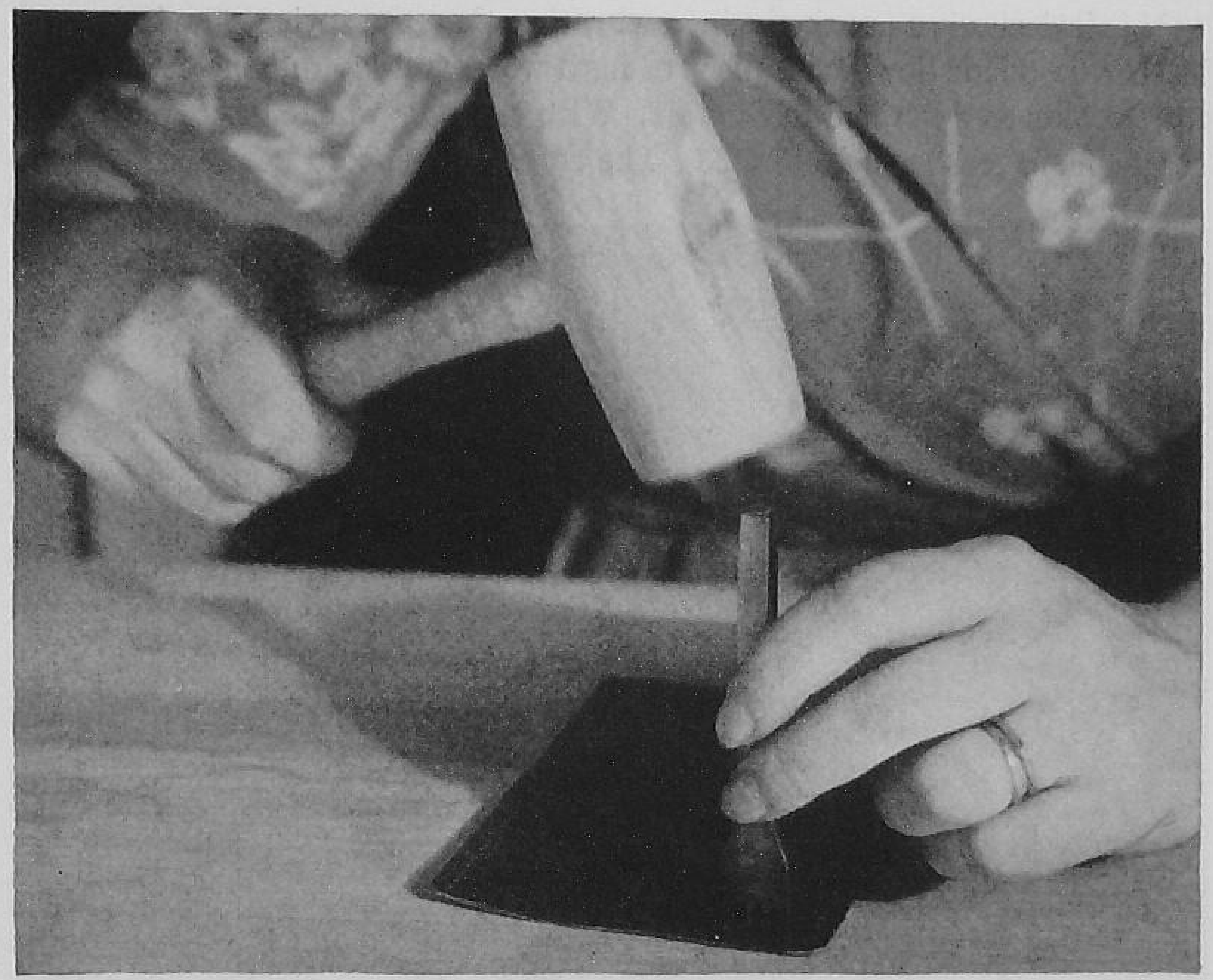


Fig. 24.

after the project has been laced as the top edge of the plate is bent to cover the lace. If the insert of the keycase is laced, both top and bottom, the plate must be attached prior to the lacing.

Center a six-hook key plate on the top of the medium-sized piece of leather and mark the location of the three holes. Make sure that the key frame is slightly below the lacing holes in order to provide for the lacing.

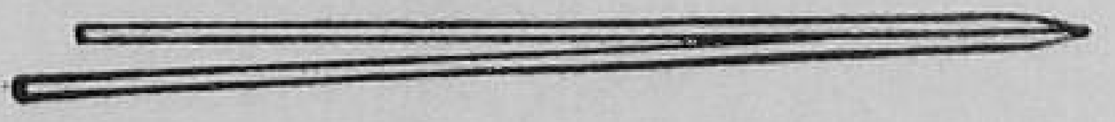


Fig. 25. Lacing needle

Select the correct sized tube on the rotary punch (see punch, Fig. 27) and rotate the head of the punch to bring the tube into cutting position. Punch the three holes.

Superimpose the key plate over the punched holes and place eyelets in the two outside holes. Make sure that the rounded and finished edges of the eyelets are against the key frame as shown in Fig. 27.

Place the assemblage upside down on a hard wood surface (see Fig. 28).

Place the eyelet setter (see Fig. 27) in the eyelet (see Fig. 28). Strike the eyelet setter several blows with a wooden mallet as shown.

The multiply split or scored end of the eyelet will spread and be forced down into the flesh side of the leather by the conical point of the eyelet setter. Strike the spread end of the eyelet several light blows with the mallet to complete the riveting operation.

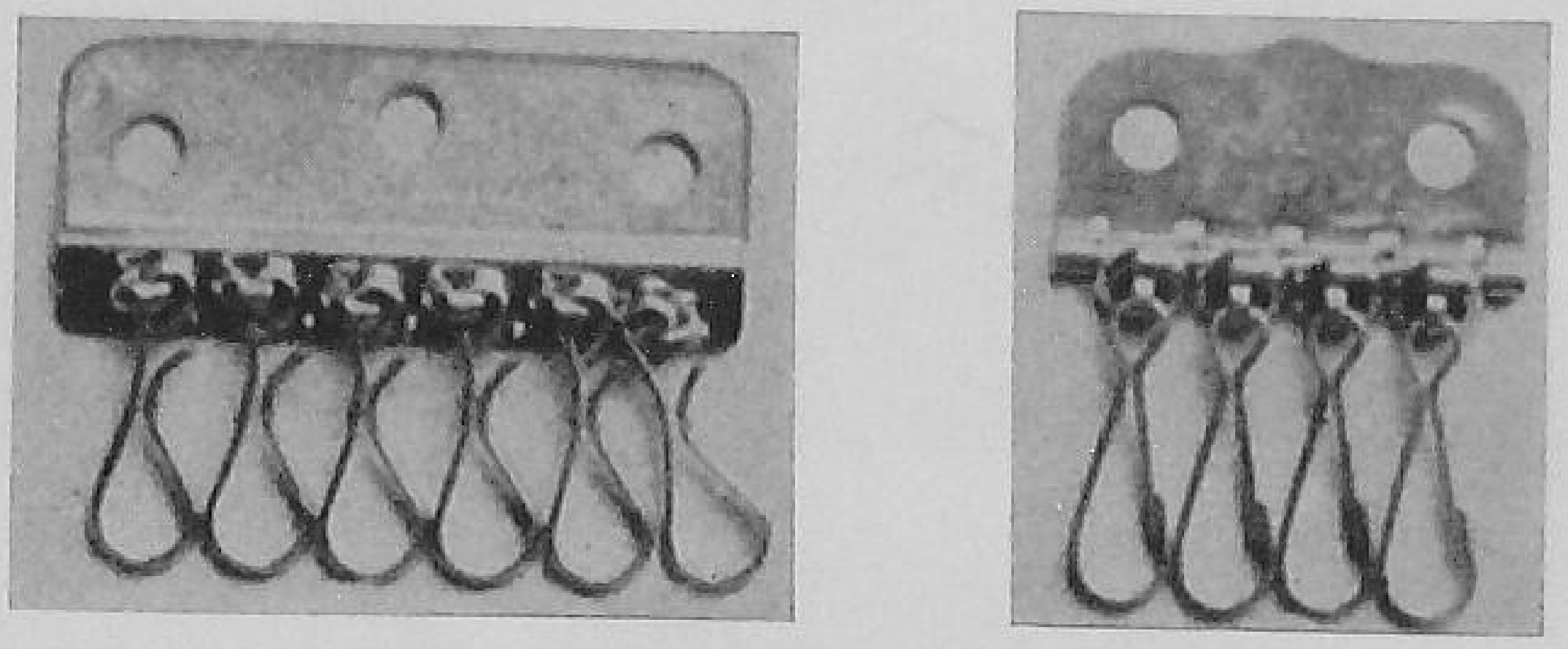


Fig. 26.
Key plates. Finest tempered steel—Solid metal swivel.

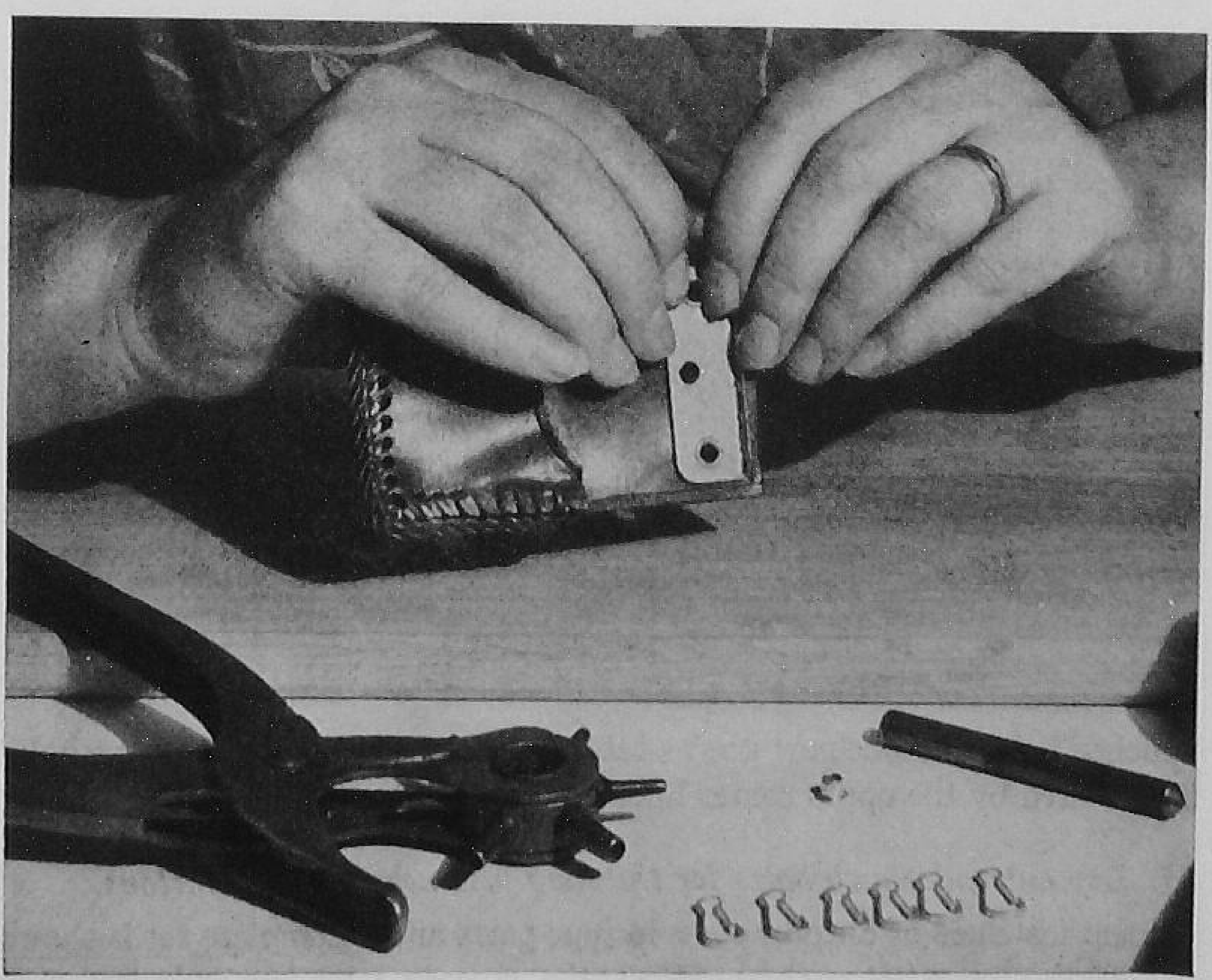


Fig. 27.

Place the third eyelet in the center hole and rivet in place. If key cases No. 1 or 2, Fig. 13, are made, it will be necessary to apply a binding post instead of a key frame. The two parts are inserted into the leather through

Fig. 28.

punched holes and one part screws into the other. The location of the holes is indicated by the upper center lines on both of the drawings.

25. Lay out and punch holes for the snap fasteners or snap buttons.

Snap fasteners or buttons come in four parts and a complete set is shown in Fig. 29. From left to right is the spring or cage, post, cap or button, and

eyelet. The cap is generally made of celluloid covered metal and comes in a variety of colors. Sizes usually range from 5/16″ to 5/8″ in diameter.

Fold the two ends of the large piece of leather over the medium-sized piece of leather and crease the folds with the thumb or a bone folder (see

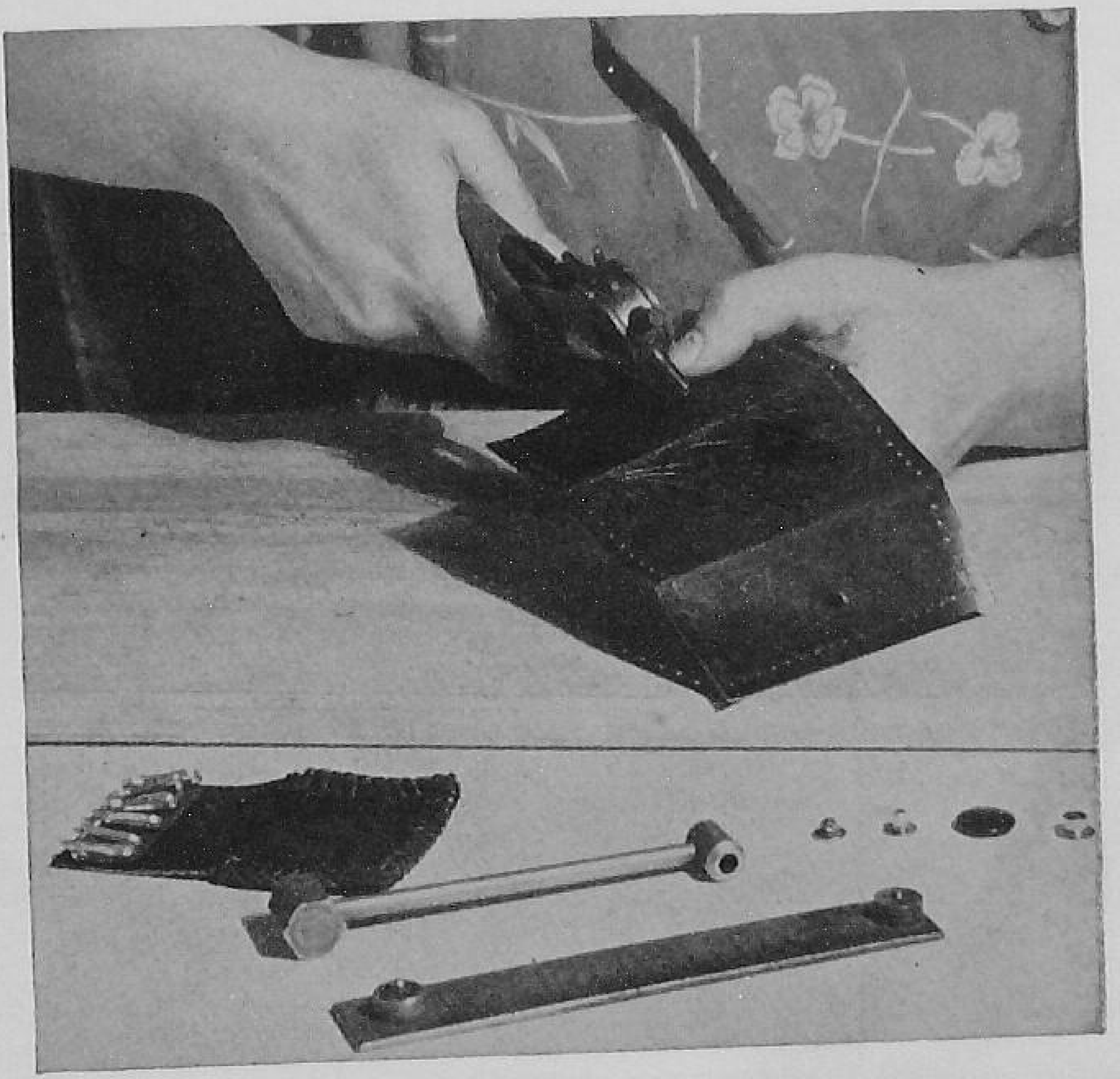


Fig. 29.

folds, Fig. 29). Whenever leather is folded, the total length of the leather is reduced. This should be taken into consideration when laying out the patterns for those projects which have folded parts. If a single piece of leather is to be folded, as in the keycase, an allowance of from 1/8″ to 5/32″ should be made on the length of the piece. If double thicknesses of leather are to be folded, as in the wallet, an allowance of from 3/16″ to 7/32″ should be made on the length of the piece.

Lay out and mark with an awl the desired location of the celluloid cap.

Select a tube on the rotary punch which is slightly smaller than the shank of the eyelet and punch a hole for the eyelet (see hole punched in Fig. 29).

Insert the eyelet with the rim against the flesh side of the leather. A

small conical tool called a bodkin is supplied with the snap fastener set. It is sometimes used to slightly expand a punched hole when inserting an eyelet. This method insures a snug fit.

Again fold the two ends of the leather over the medium-sized piece. Place the point of an awl through the eyelet and make a dot or mark. This will locate the position of the post.

Select a tube on the rotary punch which is slightly smaller than the shank of the post and punch the holes as shown in Fig. 29.

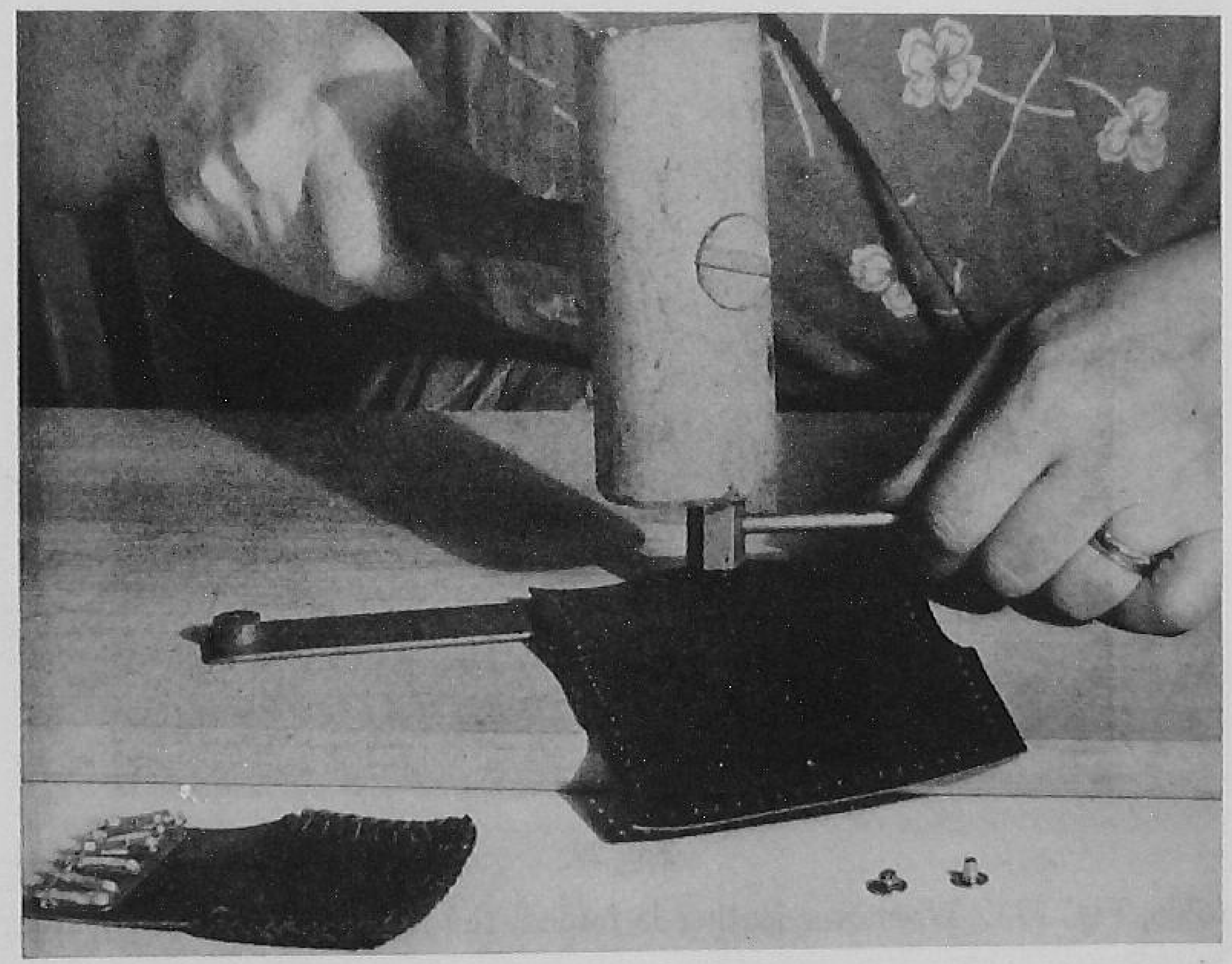


Fig. 30.

Insert the post in the hole with the rim against the flesh side of the leather.

26. Rivet snap buttons to keycase.

A snap button fastening set is shown in Fig. 29. There are two tools. The first tool is a flat piece of steel with two anvils. One anvil has a small pointed cylindrical projection and the other anvil has a very small conical projection. The second tool is a round piece of steel with two heads. One

head has a shallow spherical depression and the other head has a hole in it slightly larger in diameter than the spring.

Place the assembled eyelet and leather on top of the anvil which has the cylindrical projection (see Fig. 30). Place the celluloid button on top of the eyelet and place the head of the second tool, which has the shallow

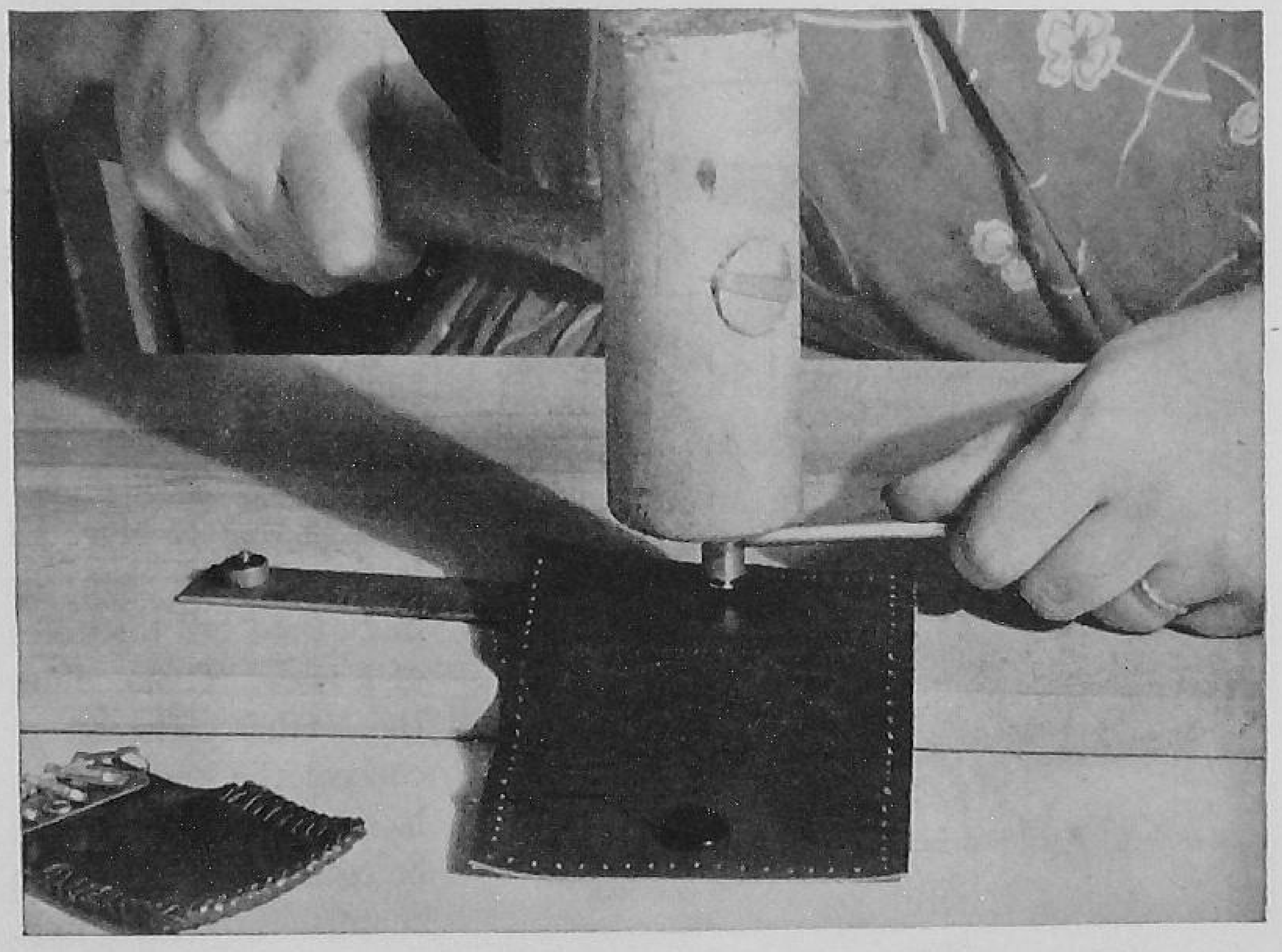


FIG. 31.

spherical depression, on top of the button. Strike the head several blows with a mallet (see Fig. 30). The eyelet will spread inside the button and the first half of the operation is complete.

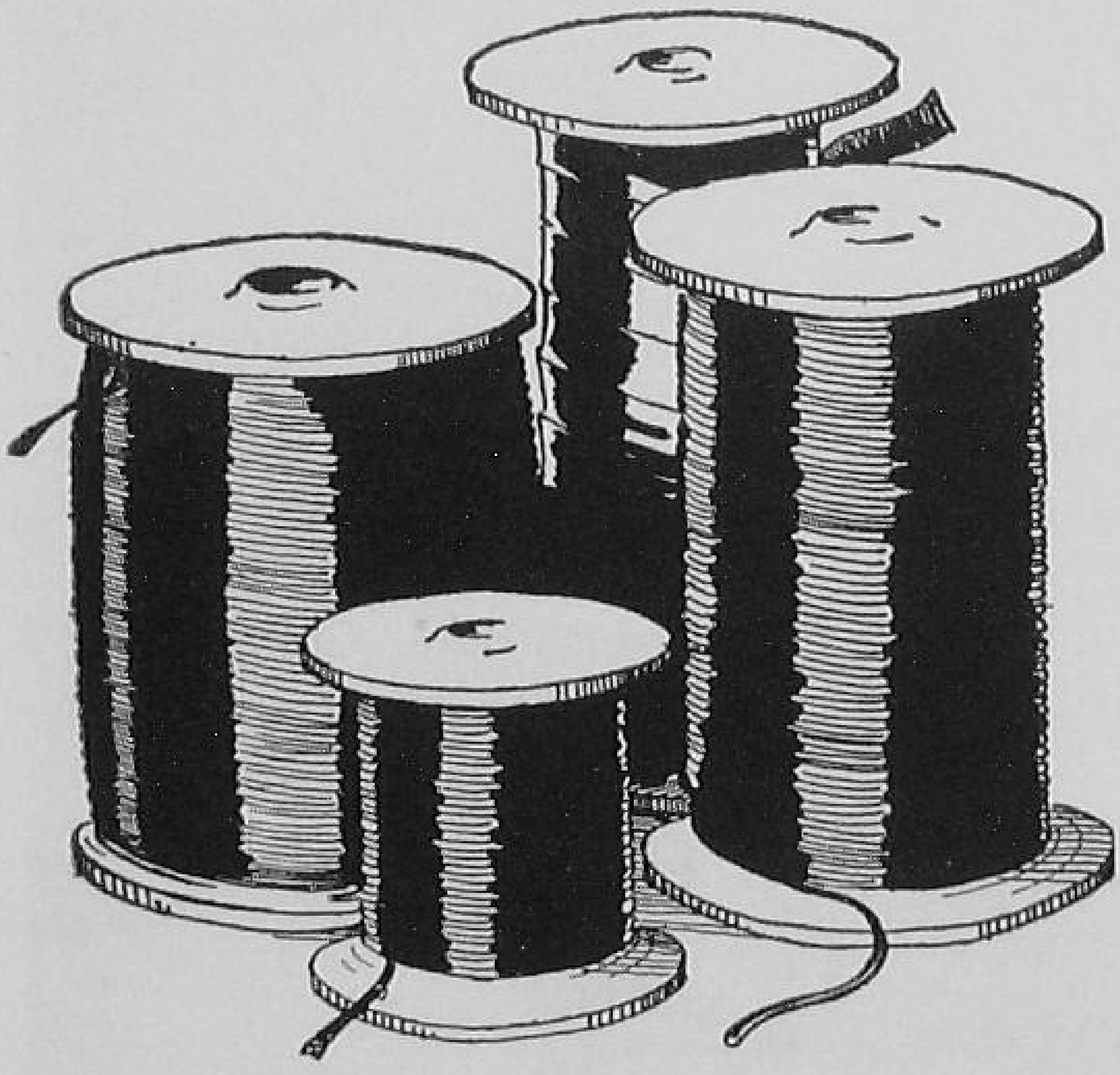
Place the assembled post and leather on top of the anvil which has the conical projection (see Fig. 31). Place the spring on top of the post and place the other head of the second tool over the top of the spring. Strike the head several blows with a mallet (see Fig. 31). The purpose of the hole is to protect the spring. The post will spread inside of the spring and the operation is complete.

27. Lace the leather keycase using the button-hole stitch.

The button-hole stitch is sometimes called the Cordova, single-loop, or

layover stitch. It is a knotted or plaited edge which wears well and neatly covers the cut edges of the leather as well as being ornamental. When using this type of stitch, measure the length of the edges to be laced and multiply the length by six. This will give the proper amount of lacing for the project.

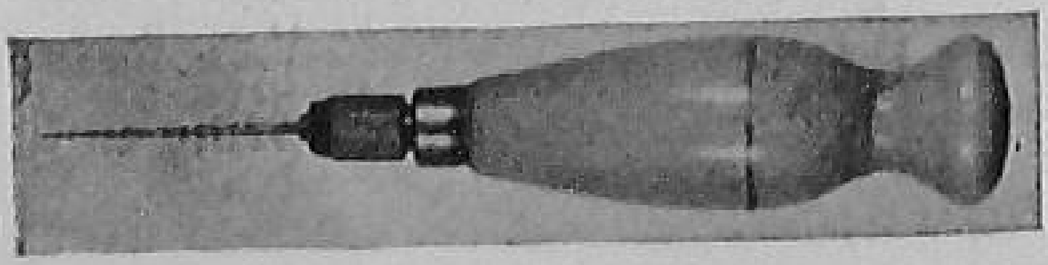
Leather lacing is usually made of goat skin and is cut in continuous lengths with the edges beveled and rolled. The lacing is dyed in practically all colors and popular widths are $\frac{3}{32}''$, $\frac{1}{8}''$, and $\frac{5}{64}''$. It may be purchased by the spool in lengths of from fifty to one thousand yards.



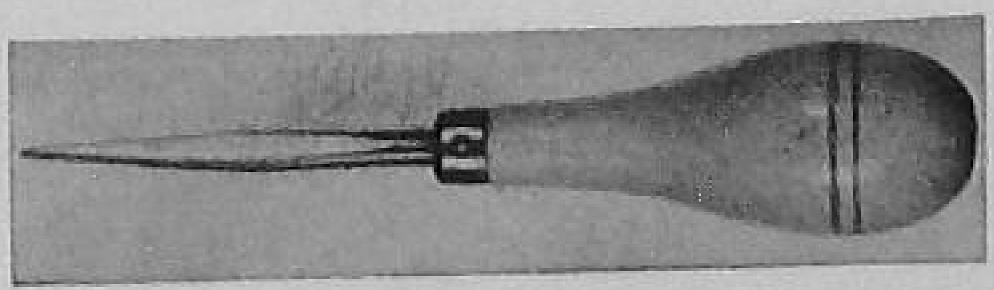
It is well to start all lacing where there is more than one thickness of leather. This enables the leathercraftsman to conceal the ends of the lace where they cannot be readily noticed, when he finishes the last stitch.

A good rule to follow is to make three complete stitches on each corner. This makes it necessary to pass the lace through the corner hole three times and an awl or fid (see Fig. 32) is very useful in enlarging the hole so that it will accommodate the extra widths of lace. All sharp leather corners should be slightly cut off at a 45 degree angle (see *A* and *B*, Fig. 22) or

Fig. 32.



For piercing leather, making small holes, for sewing, etc.



For enlarging holes, especially useful in sewing belts. Also used for stripping, tightening lacing, knots, etc.

slightly rounded as shown at *C* and *D*, Fig. 22. The resulting laced corner is strong and well rounded and the outer edge of the lacing will have an even appearance (see right-hand corner, Fig. 39).

Another good general rule to follow is to use not more than four feet of

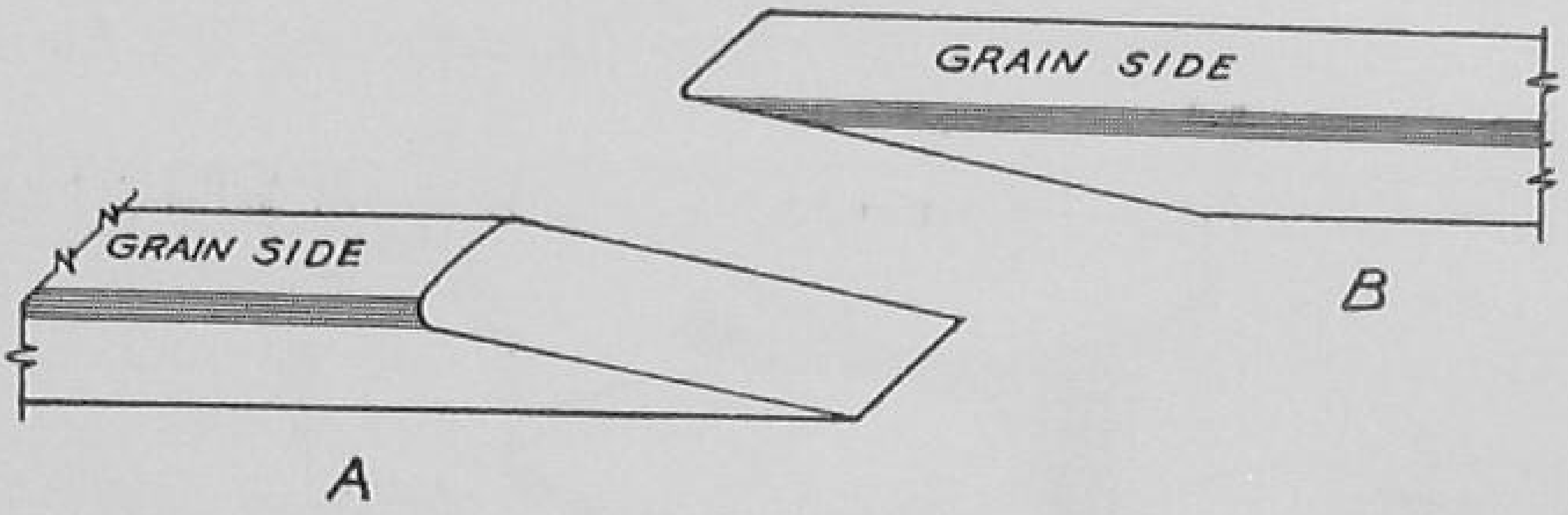


FIG. 33.

lacing at one time. If a longer piece is used it becomes frayed and will break. If the lacing breaks or a new piece is to be added, proceed as follows.

With a sharp knife, trim the ends of the lacing square. Grasp the knife in the right hand and place the blade flat, on the flesh side of the short end

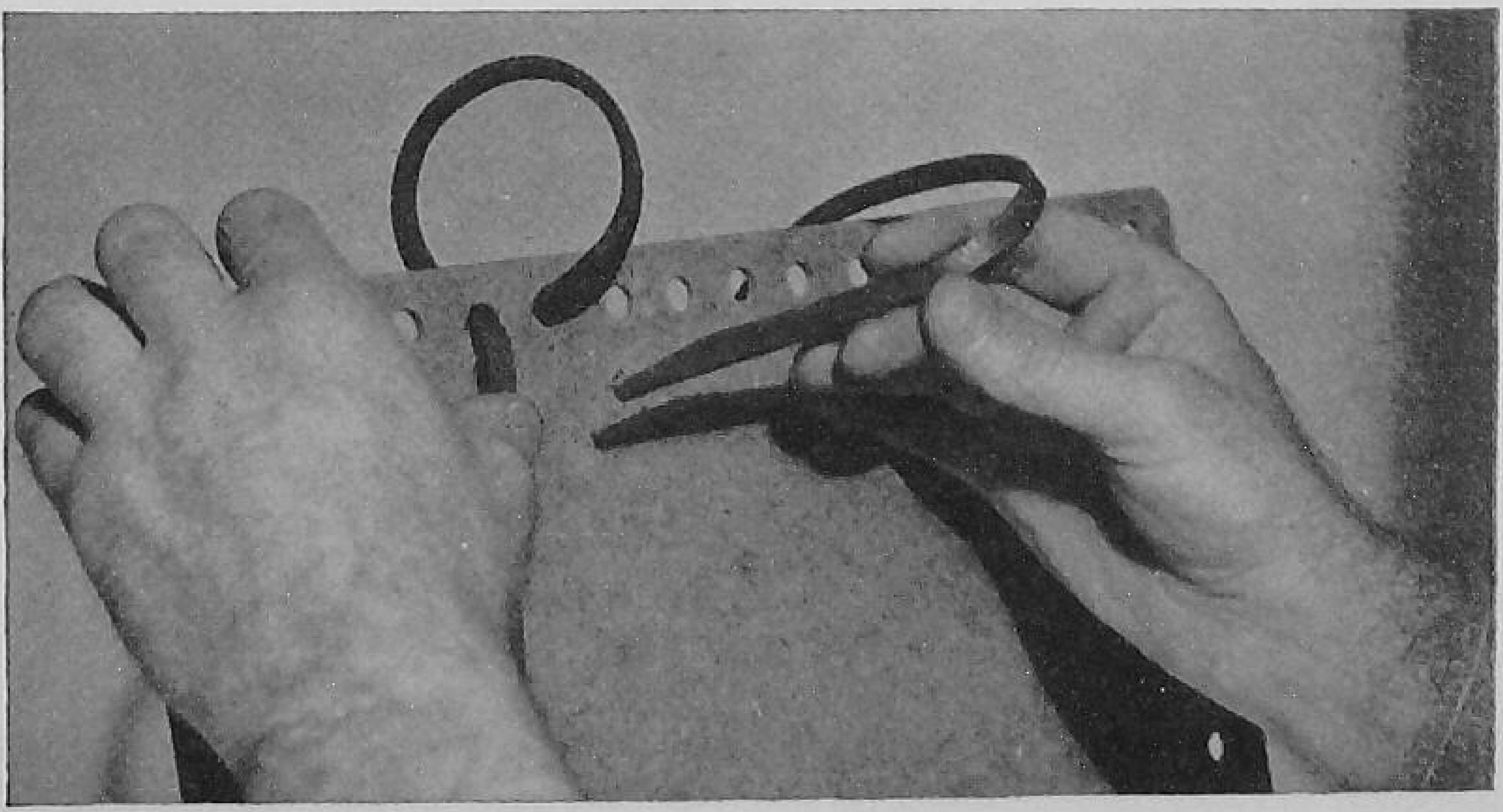


FIG. 34.

of the lace. The cutting edge of the knife should be toward the trimmed end of the lace and approximately ½″ to ⅝″ back. Tilt the blade slightly downward and, with a sliding stroke, push it forward and to the right at

the same time. The downward pressure on the stroke should be increased as the blade of the knife approaches the end of the lace. This will produce a beveled end (see Fig. 33). Repeat the operation on the piece of lace which is to be added, cutting (skiving) the grain side instead of the flesh side. Place a small amount of leather cement on the slanting surfaces and allow the cement to become tacky. Press the splice together for several

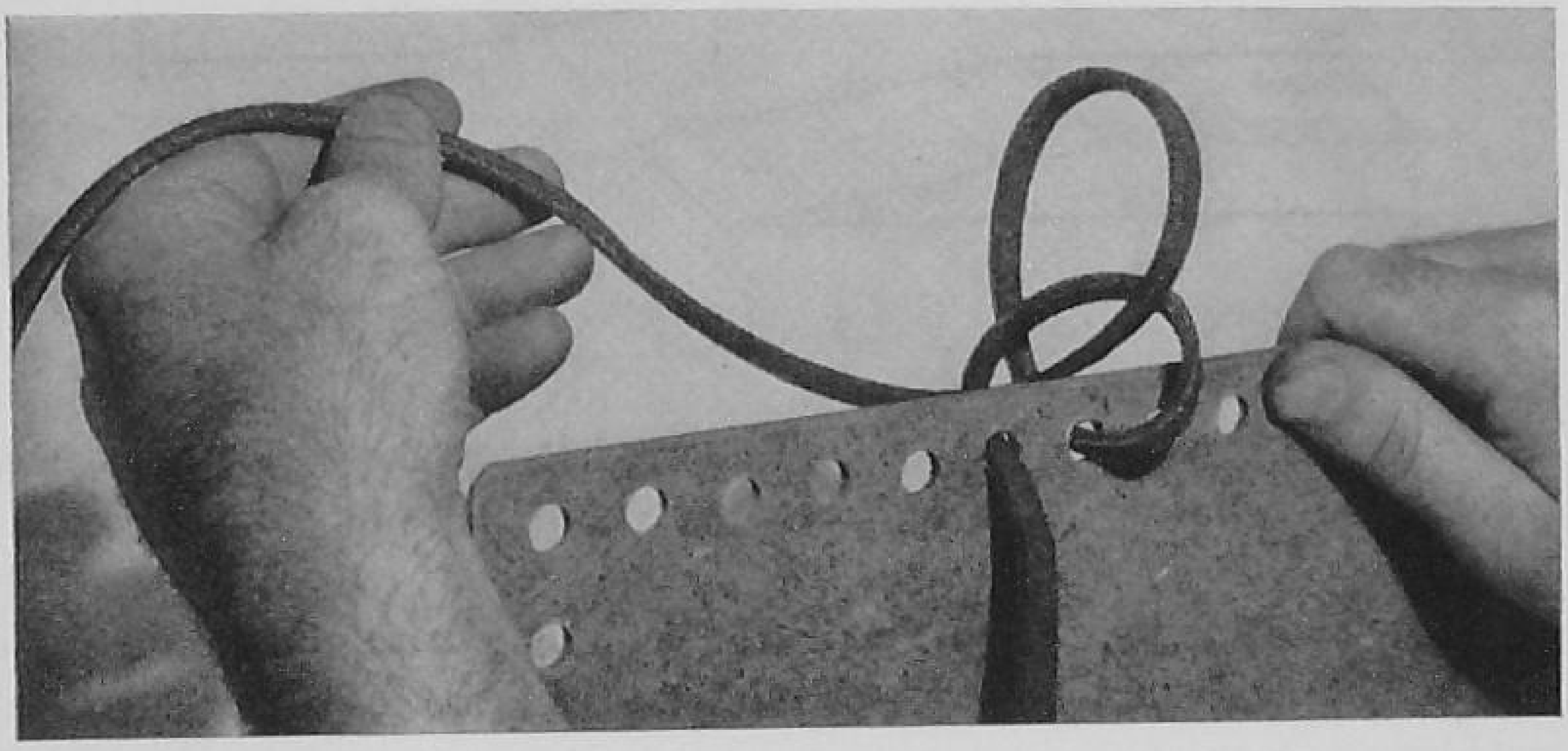


FIG. 35.

minutes and proceed with the lacing being careful of the joint until it has set.

Hold the keycase in the left hand with the tooled or decorated side toward you. Start the lace in the center of the top edge and lace from left to right as follows:

A. Insert the lace, from front to back, into one of the lacing holes. Draw it through in back until only several inches remain in front. Carry the lace over the top edge and insert it, from front to back, in the next hole. Again draw it through in the back until a small loop is left (see Fig. 34).

B. Again carry the lace over the top edge (see Fig. 34) and insert it through the loop, from front to back (see Fig. 35). Make sure that the lace passes through the loop *and to the left of itself*. If the lace is passed through the loop and to the right of itself, the knot will not form properly.

C. It will be noticed that there are two loops (see Fig. 35). With the right hand, pull on the right hand loop as shown in Fig. 36. This will draw the left hand or first loop, tightly against the edge of the leather. Pull the last loop down as shown in Fig. 37. Repeat the operation until the entire project is laced.

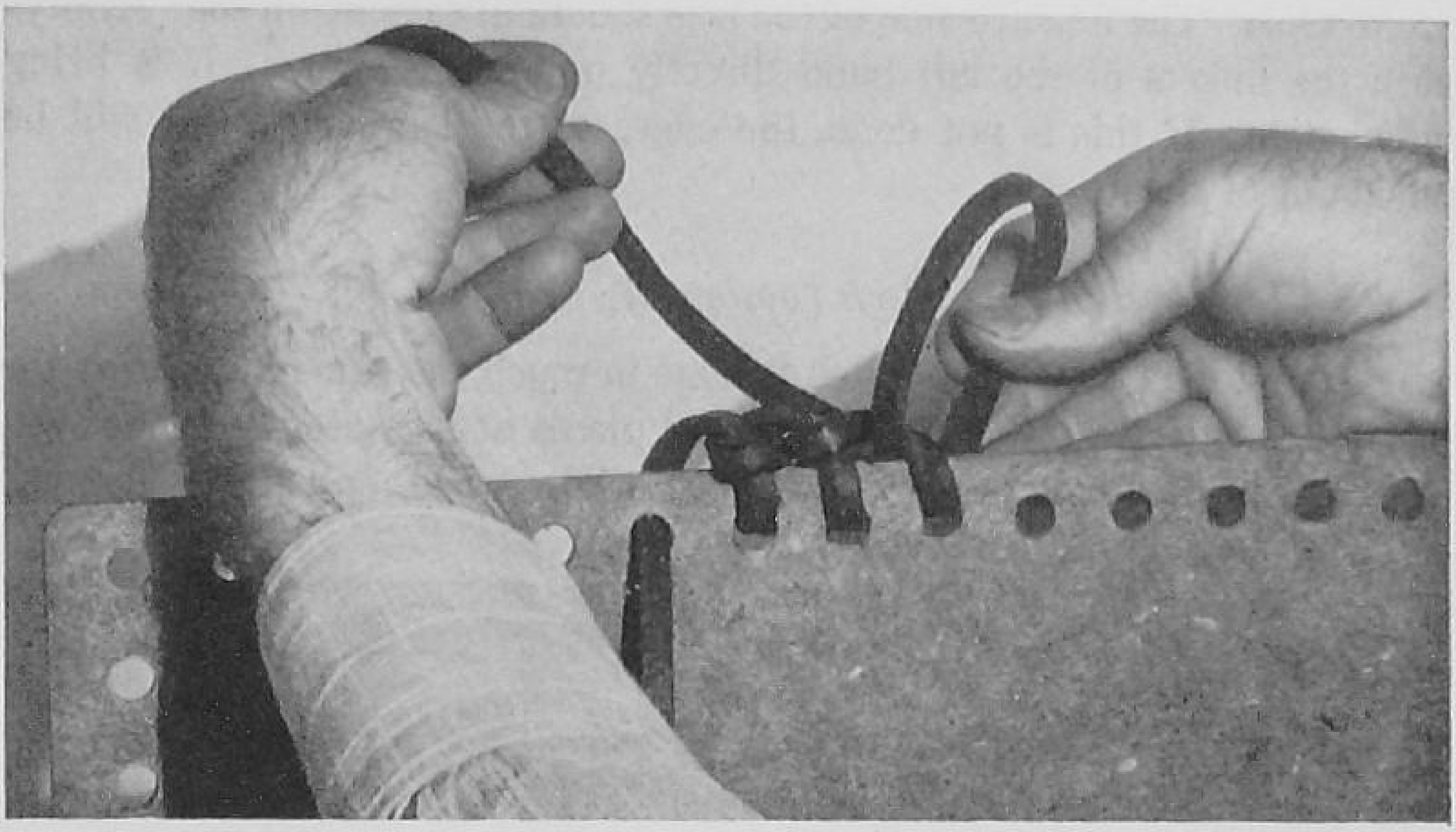


Fig. 36.

Be sure that each knot is directly above each punched hole and that the lacing does not slant. If the end of the lace is cut to a point it can be inserted in the holes with greater ease. Some leathercraftsmen dip the end of the lace in leather glue and allow it to harden. This keeps the end of the lace stiff and it will enter the holes much more readily. Do not allow the

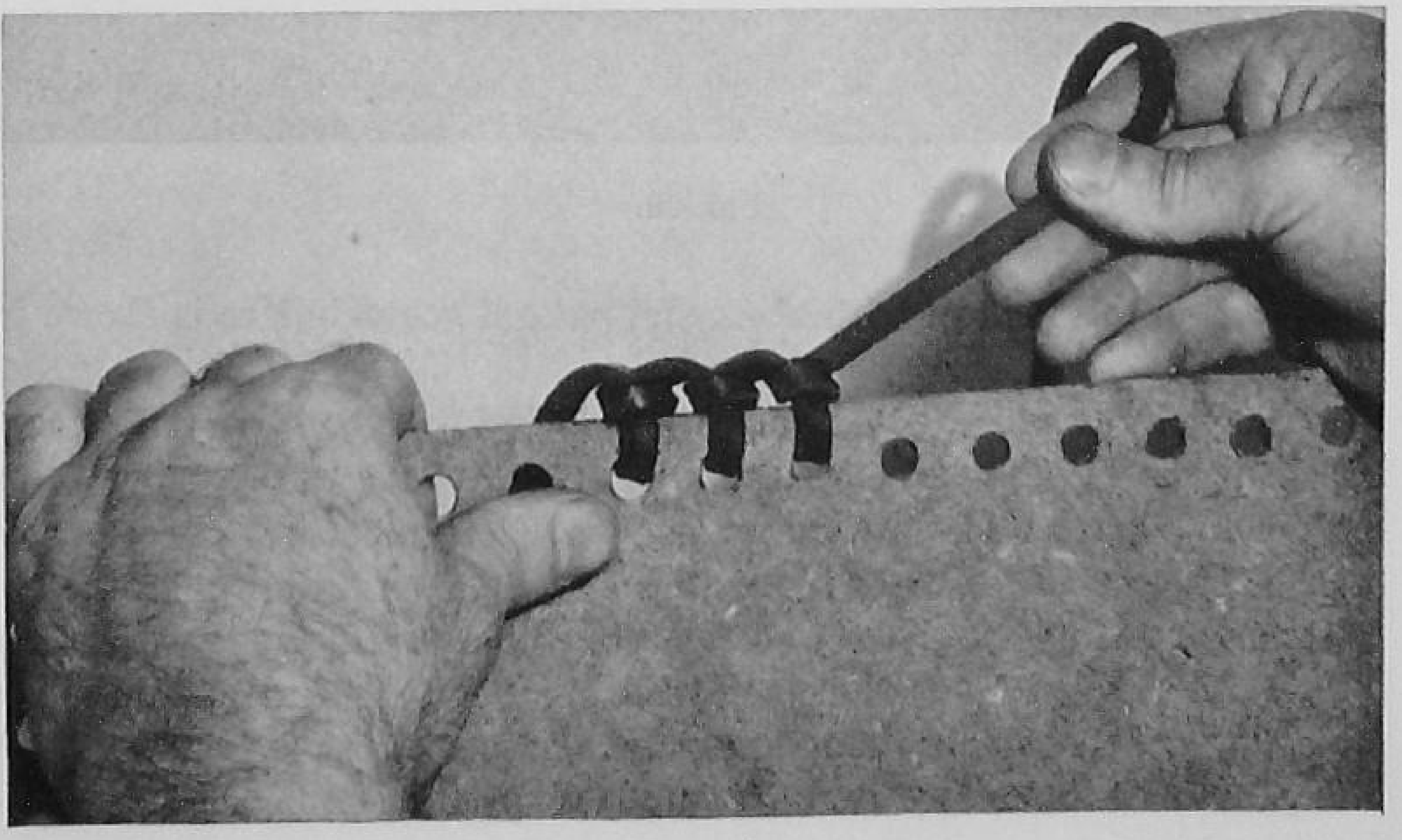


Fig. 37.

lace to twist. The finished side of the lace should always be on top. Always place the fingers of the left hand directly under the knot as it is being pulled tight. If this is not done, the edges of the leather project will be pulled out of shape.

28. Two-tone button-hole stitch (optional).

The two-tone button-hole stitch is done in much the same manner as the button-hole stitch. Two different colored pieces of lace are used, however, instead of just a single piece of lacing material. A leather wallet which has

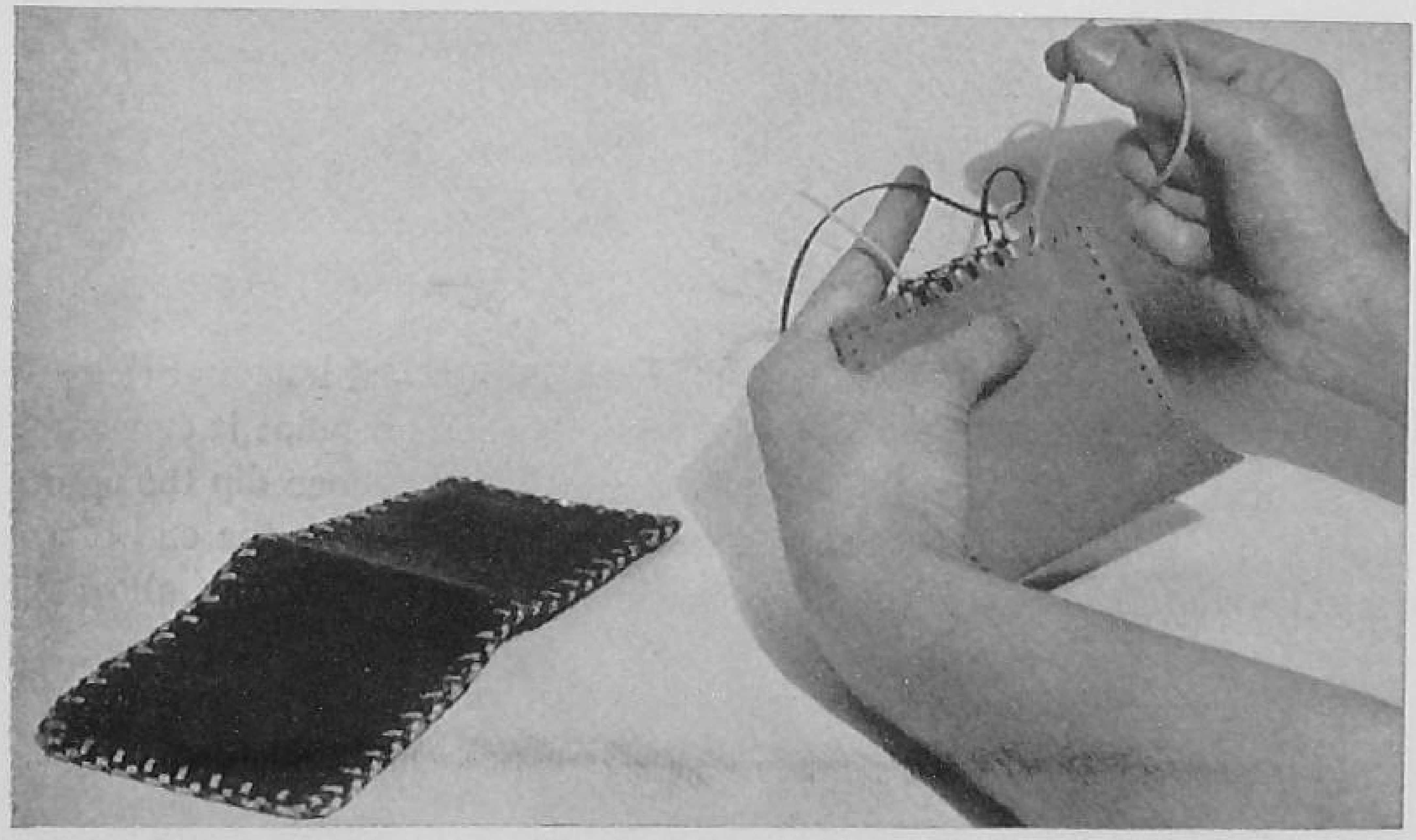


Fig. 38.

been laced in this manner with black and natural goatskin lace is shown in Fig. 38.

A. Begin by passing a length of natural lacing from front to back, leaving about two inches remaining on the front side of the leather. Bend this short end up and hold it with the fingers of the left hand.

B. Take a length of black lacing and insert one end down between the pieces of leather and to the right of the piece of natural lacing.

C. Take the other end of the black lace and pass it clockwise around the projecting or short end of the natural lace.

D. Insert the black lace from front to back in the next lacing hole, leaving a loop.

E. Drop the black lace and bring the natural lace over across the top of the leather project and insert it through the black loop, from front to back.

F. Pull up the black loop first and the natural loop second.

G. Make a loop with the natural lace in the next lacing hole. Drop the natural lace and bring the black lace across the top edge of the leather project and insert it through the natural loop. Pull up the natural loop first and the black loop second.

H. Continue the lacing making alternate loops with the black and natural lacing. The lacing is finished in much the same manner as will be described in the next step.

29. Join or finish the button-hole stitch.

As was stated in Step 27, lacing should always be started where there are two or more layers of leather. This makes it possible to conceal the

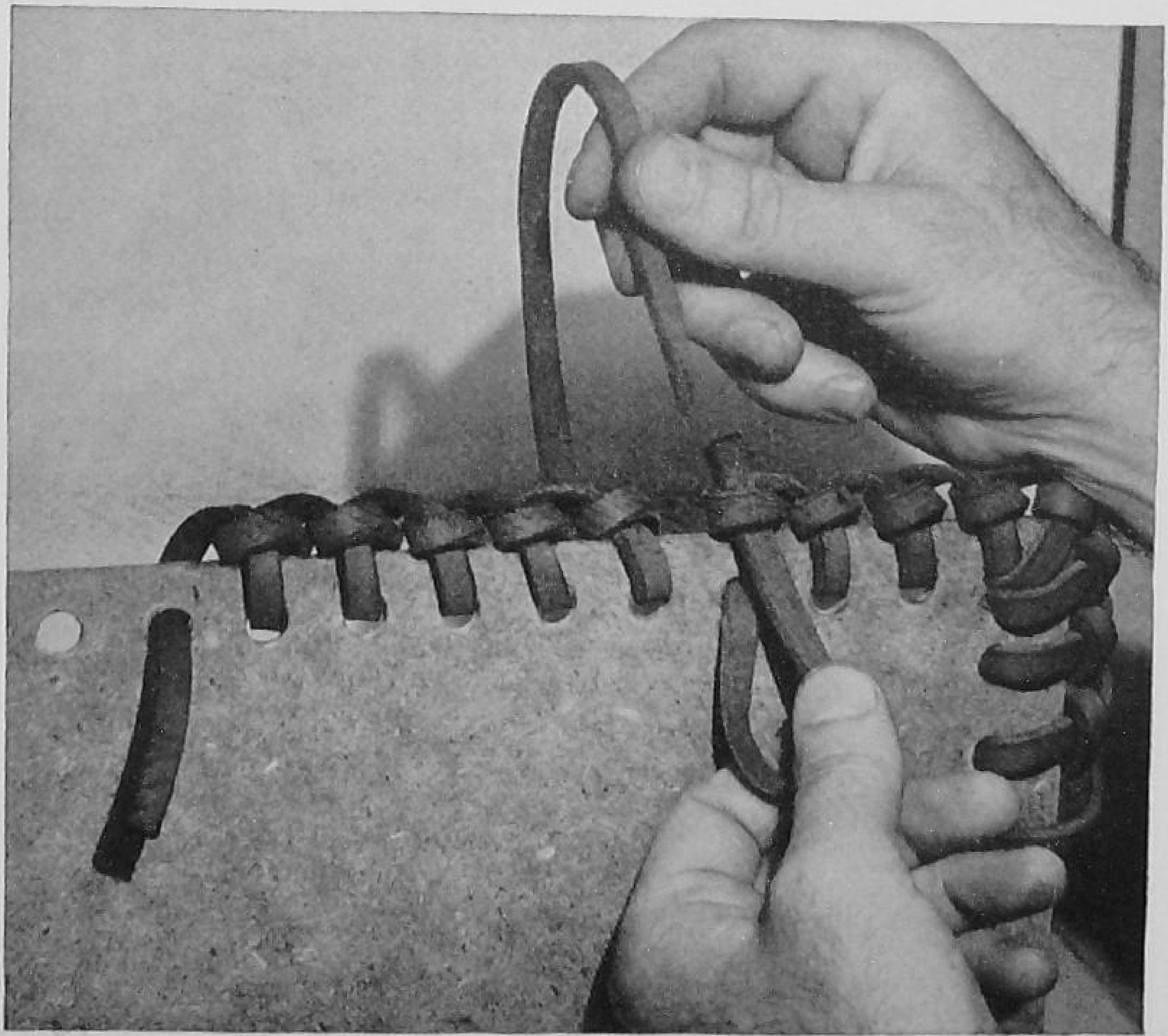


FIG. 39.

connecting ends of lace between the two pieces. If this is not done, the ends of the lace must be tucked under several stitches on the under side of the laced project. This is unsightly and should be avoided wherever possible.

After lacing completely around the project, the lacing is joined as follows:

A. Pull out the short end of the lace which was left in the first hole when you began to lace. Make a final stitch in this hole.

B. Pull the short end of the lace down and out of its loop (see Fig. 39), leaving the loop intact.

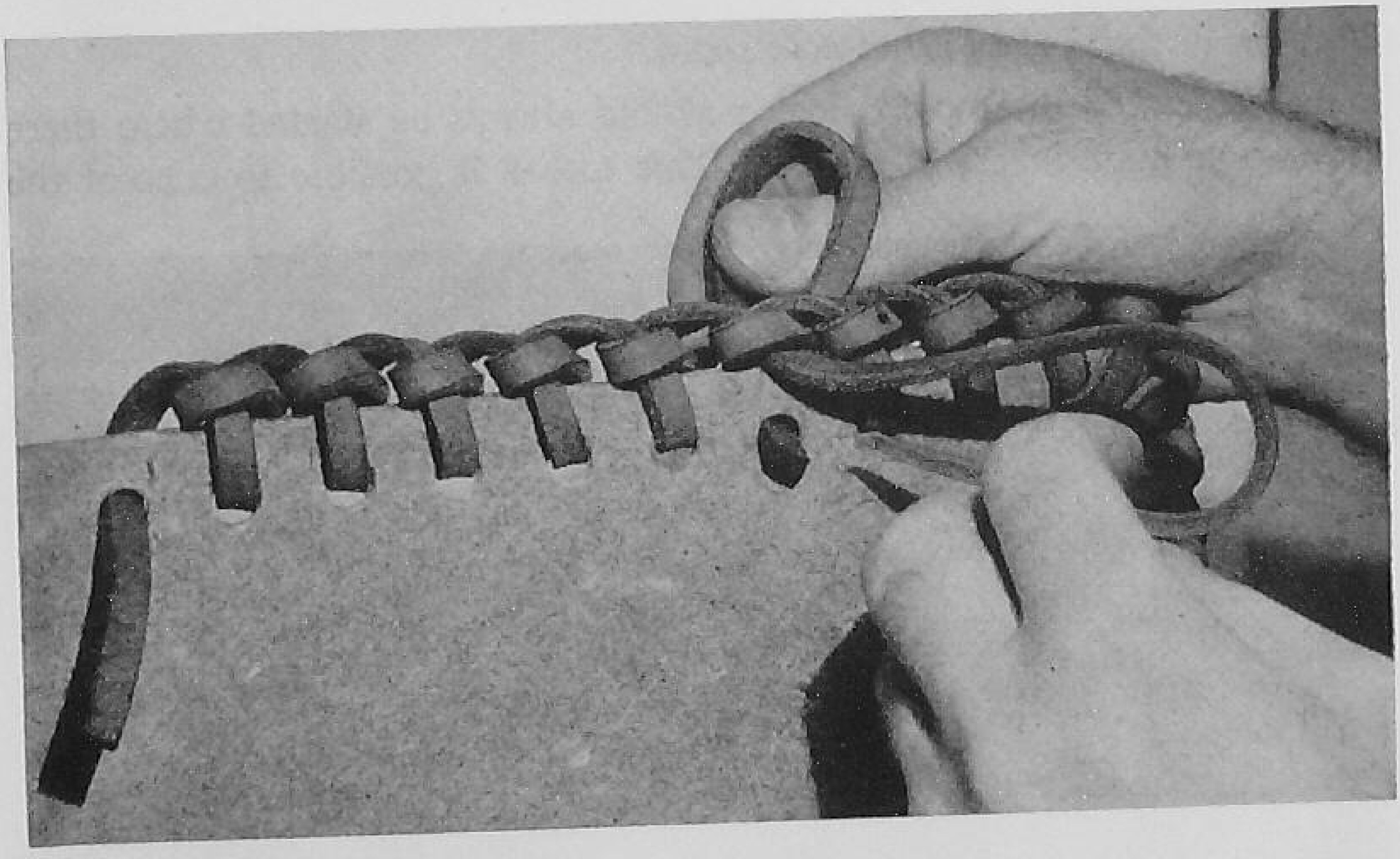


Fig. 40.

C. Bring the long end of the lacing up from the back and insert it down through the loop as indicated in Fig. 39.

D. Draw the short end of the lace out of the hole in the *front* piece of leather (see Fig. 40) and allow it to lay *between* the two layers of leather.

E. Insert the long end of the lacing into the same hole as indicated in Fig. 40 and also allow it to lay between the two layers of leather. Figure 41 shows the stitch completely joined. The two ends of the lace are glued down between the two pieces of leather.

F. When the lacing has been completed, lay the key case on a hard wood surface and tap the lacing lightly with a mallet (see Fig. 42). This flattens

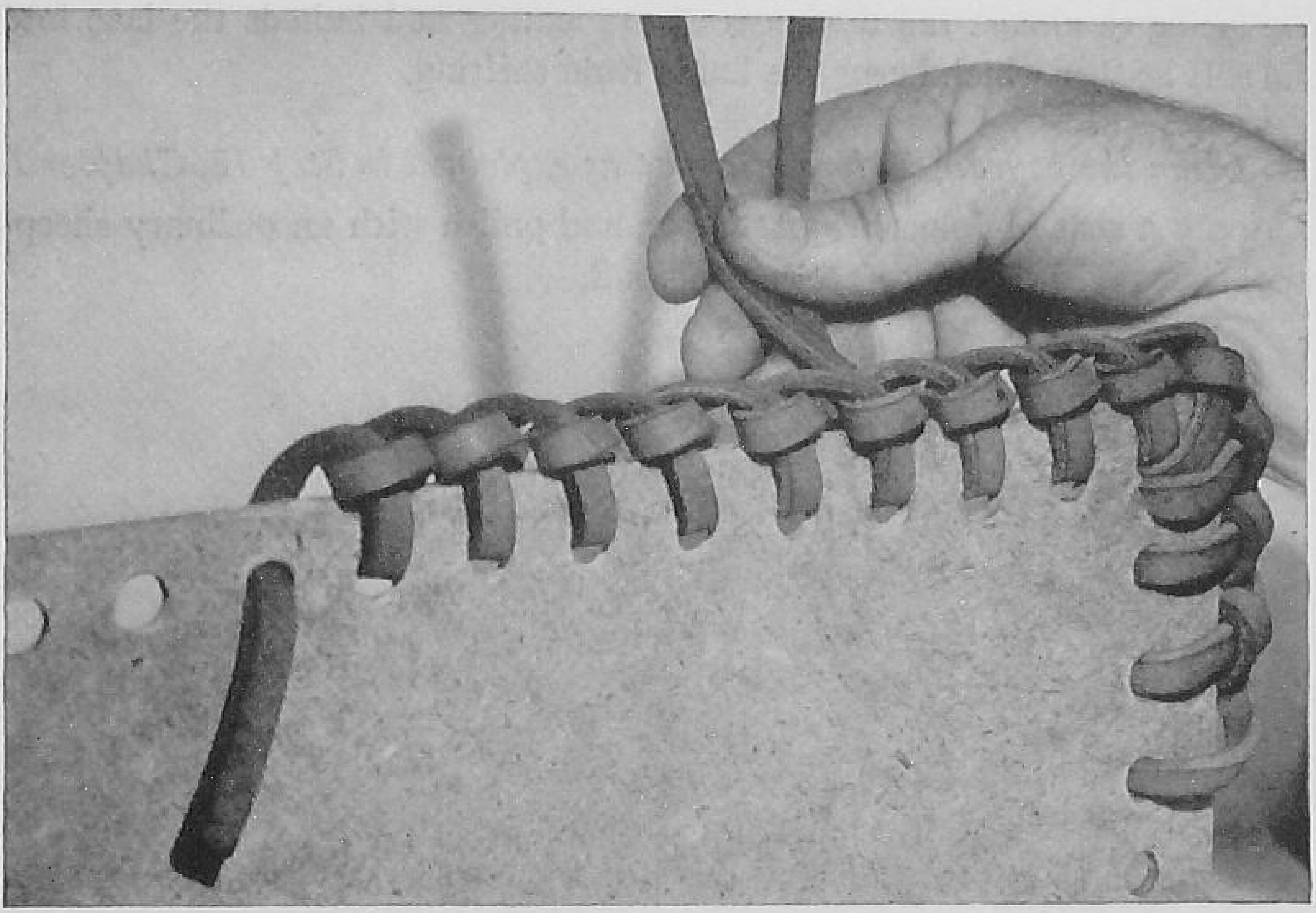


Fig. 41.

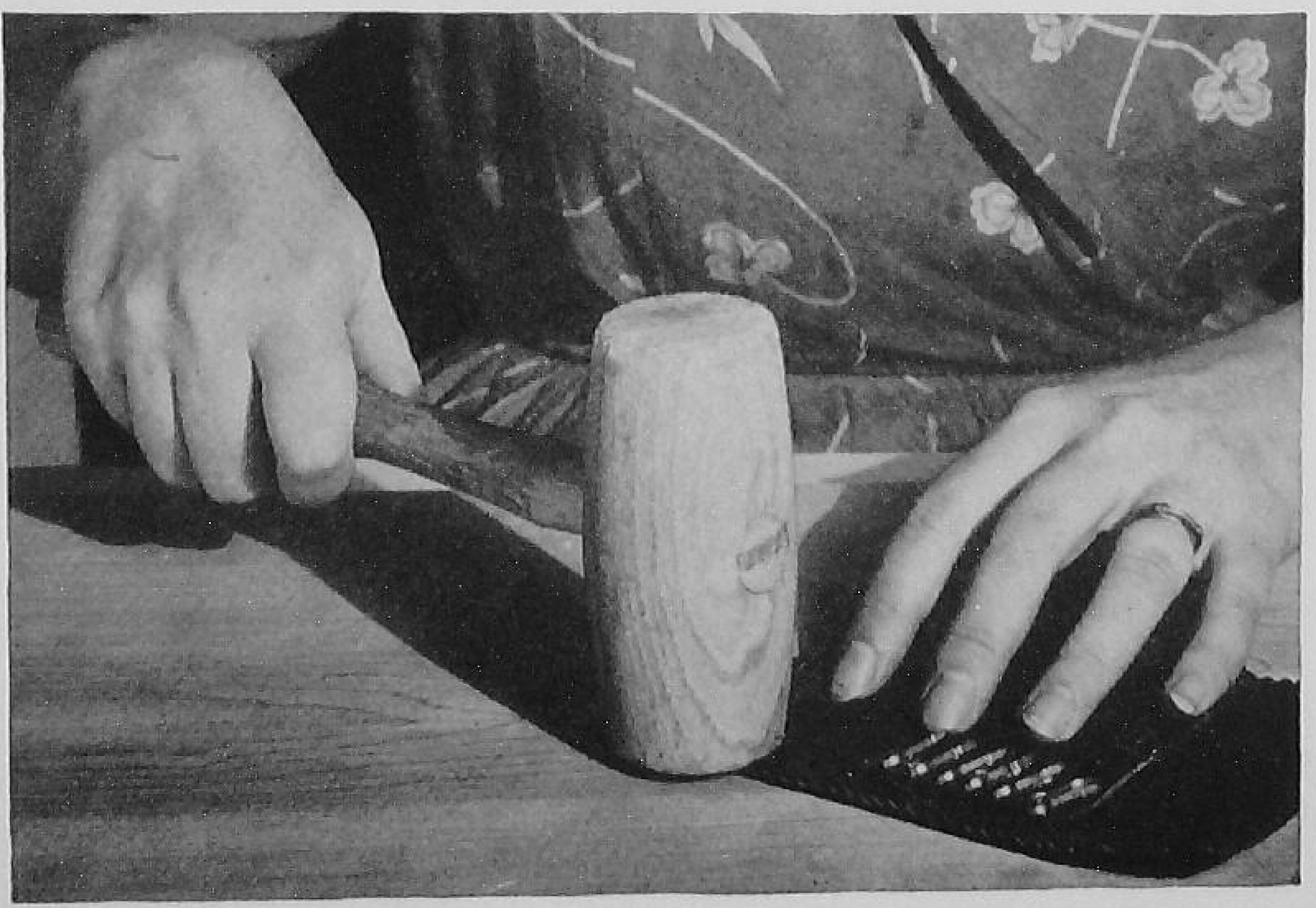


Fig. 42.

the lacing to almost the thickness of the leather and imbeds the lace into the soft leather which keeps the knots from shifting.

30. Clean the keycase with saddle soap as explained in Step 12, Chapter I.

Apply a coat of Johnson's paste wax and polish with an ordinary sheep-wool shoe polisher or a soft, clean rag pad.

Chapter III

HOW TO MAKE A BILLFOLD OR WALLET

The billfold is an attractive and comparatively easy project to make. The leathercraftsman can design original patterns for the project or he can duplicate various patterns which he has observed. Fig. 43 indicates a few dimensions and pocket shapes which might be helpful to the beginner.

31. *Select a suitable design (see Step 1, Chapter I).*
32. *Trace design (see Step 2, Chapter I).*
33. *Cut leather to desired dimensions (see Step 3, Chapter I, or Steps 15 and 16, Chapter II).*
34. *Moisten the leather (see Step 4, Chapter I).*
35. *Trace design on billfold (see Step 5, Chapter I).*
36. *Dampen leather for tooling (see Step 6, Chapter I).*

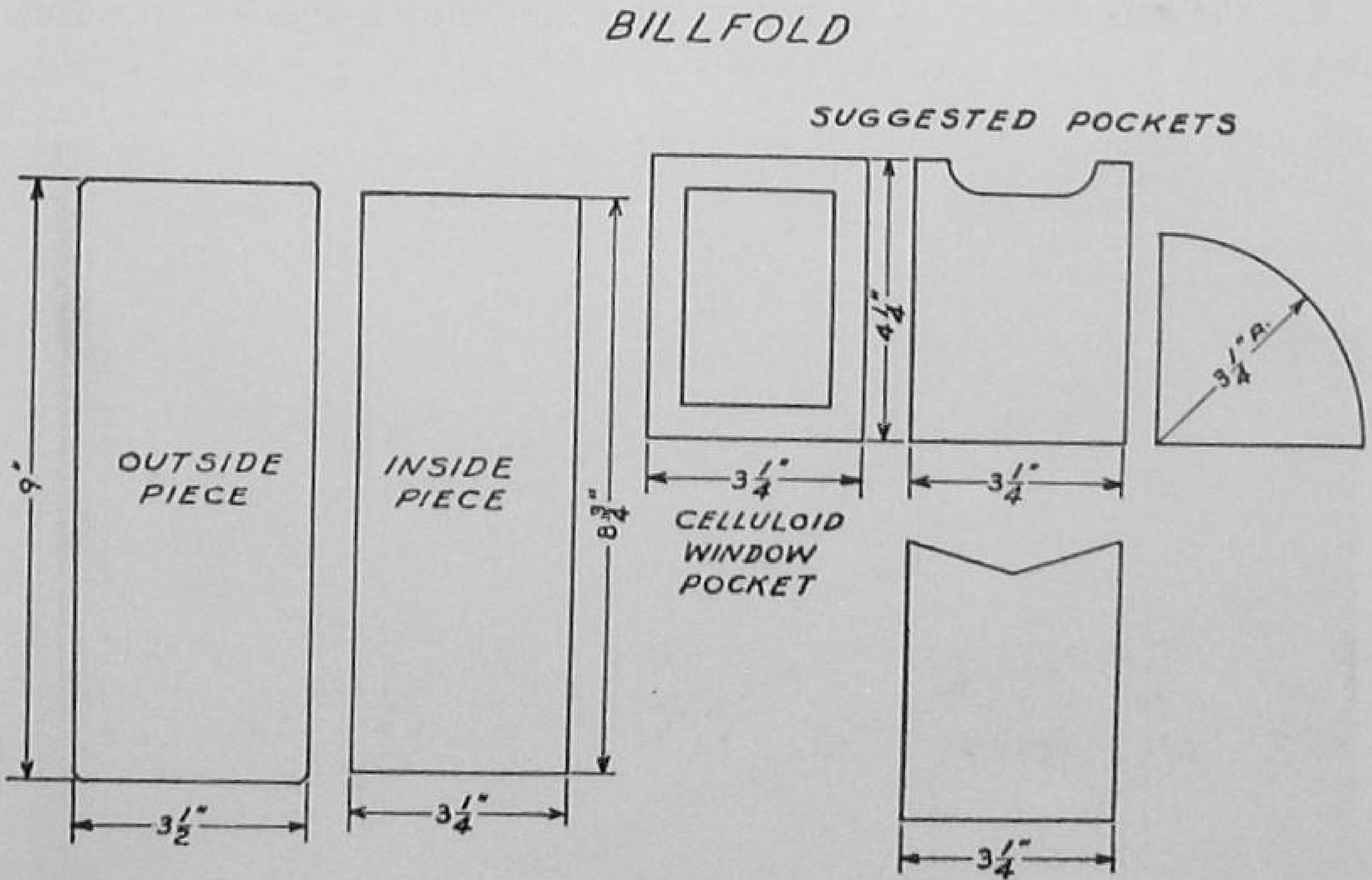


Fig. 43.

37. Tool design (see Step 7, Chapter I).

38. Bring design into relief by "flat modeling."

Place the leather flesh side down on a piece of glass or marble. With the spoon end of the modeling tool or with the modeler described in Fig. 44, press down all of the *background* of the design. Use a circular motion and considerable downward pressure. Tip the modeler upward, as was the case in beveling (see Step 20, Chapter II), when depressing the background near the lines of the design. All the designs which are flat modeled should have a border to which to model. The background may be further depressed by placing several paper towels between the leather and the glass (see Fig. 45).

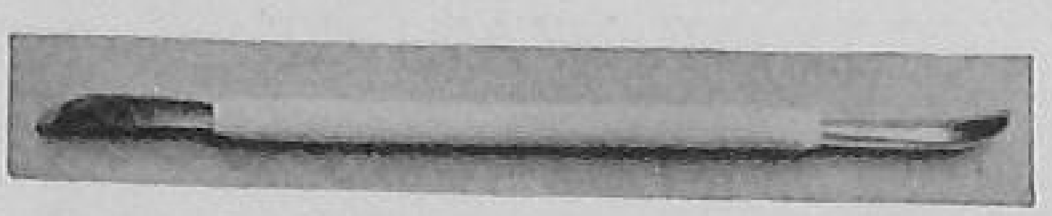


FIG. 44. Modeling tool. This tool is flat at both ends. Excellent for modeling broad surfaces. Stainless steel.

39. Inlay leather (optional).

Another form of decoration in leatherwork is inlaying. The process is much the same as wood inlaying and consists of cutting out various pieces of colored leather and gluing them into recesses which have been cut into the leather project.

Lay the outside piece of leather for the wallet flesh side down on a cutting board. Using a sharp knife and a straight edge, cut two parallelogram

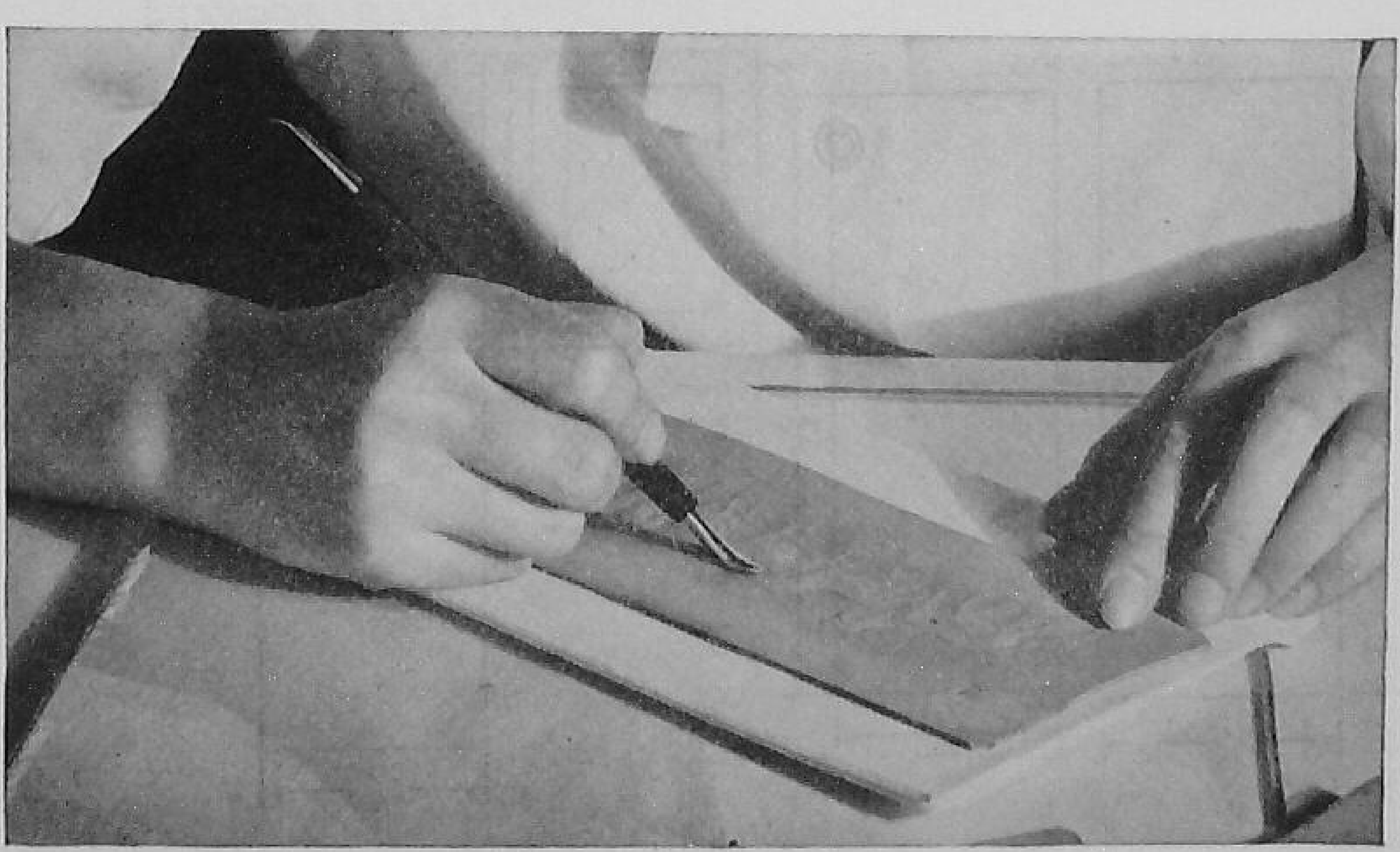


FIG. 45.

shaped holes out of the center of each side. Line the entire piece of leather (see Step 42). This provides the necessary recess for the colored pieces of leather.

Using a straight edge and the point of a sharp knife, layout the designs carefully on two different colored pieces of scrap leather. With the straight

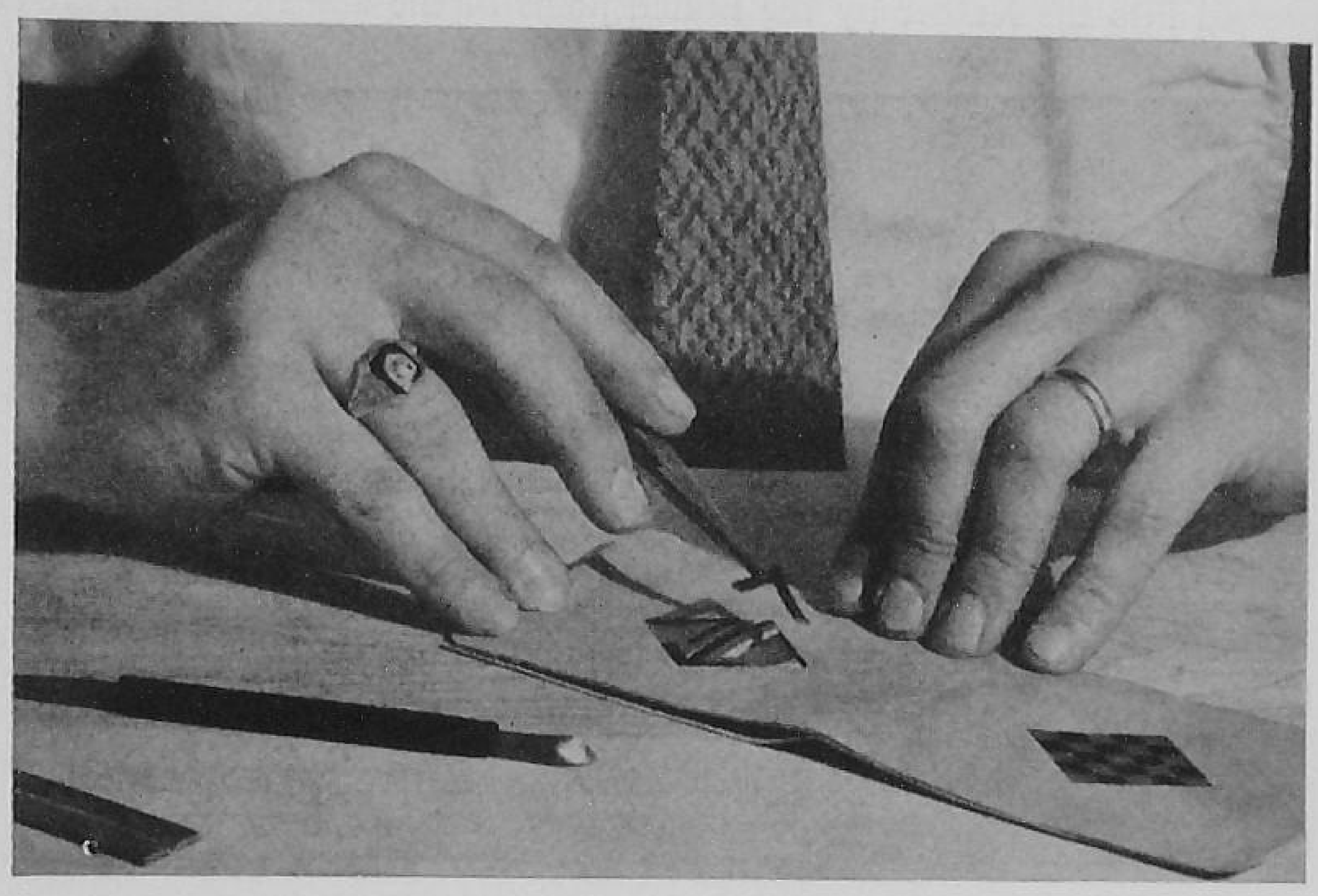


FIG. 46.

edge and a sharp knife, carefully cut out the various pieces of the design. Make sure that the knife makes a straight and square cut.

Apply leather cement to the recess and to the flesh side of each piece of the design. Fit each piece carefully into place in the recess (see Fig. 46). The spoon end of the modeling tool may be used to smooth the surfaces of the design. Place the leather under a press or weight overnight.

40. Write with imitation gold or silver on leather project (optional).

An electric wood burning pencil or stylus may be used with foil transfer paper for writing or printing on leather. The electric pencil has four differently shaped tips for burning wood or leather and the heat generally comes from a nichrome heating element which is located in the handle. The foil transfer paper comes in rolls of various widths, lengths, and colors. Gold, silver, and black are usually the most popular colors.

Lay the leather flesh side down on a smooth hard surface. Plug in the electric pencil and allow it to heat until moisture on the finger will sizzle when the point is touched.

Place the foil colored side down on the leather. Write or print your name and address on the foil (see Fig. 47). The colored foil will be depressed into the leather by the heated point of the electric pencil. It is

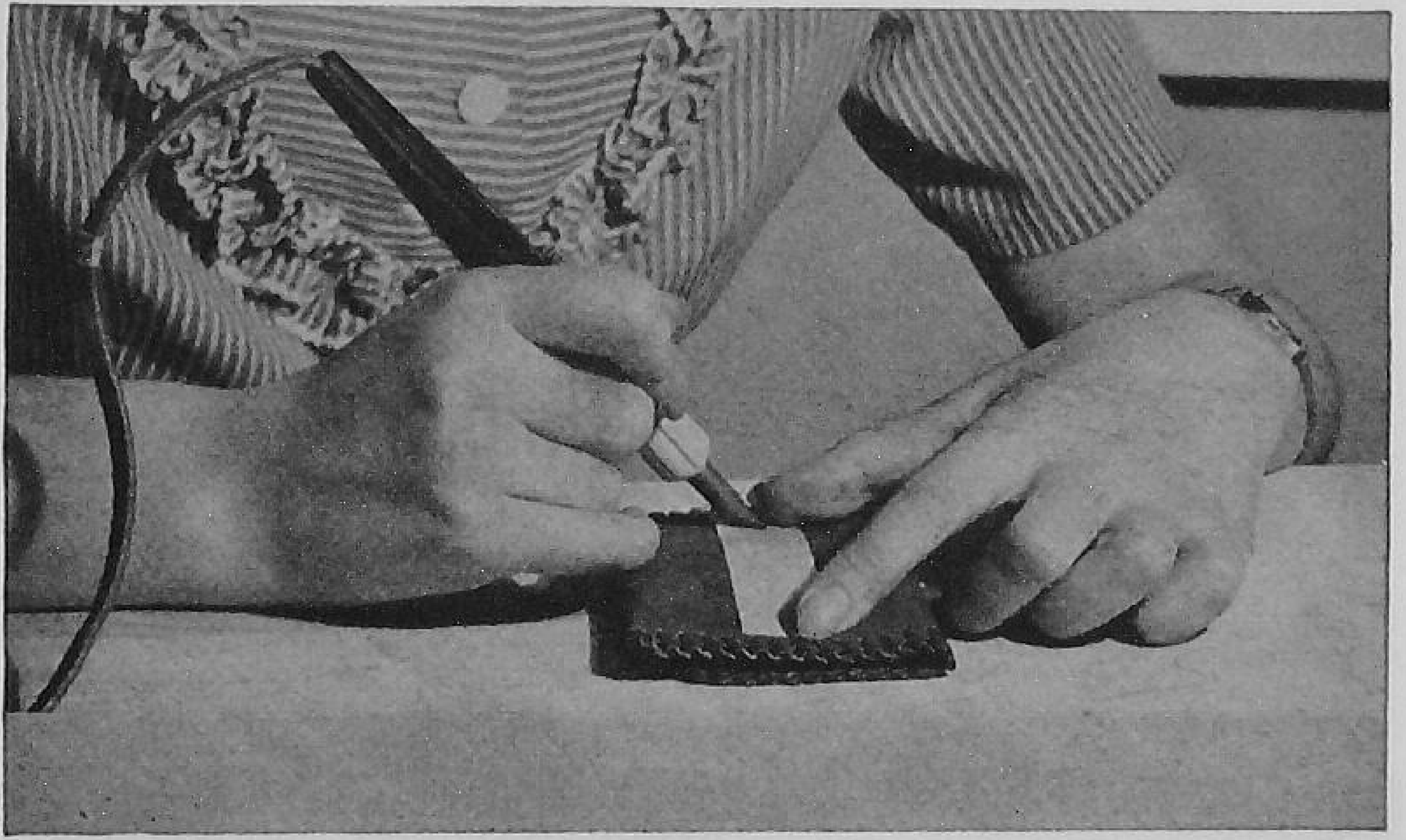


Fig. 47.

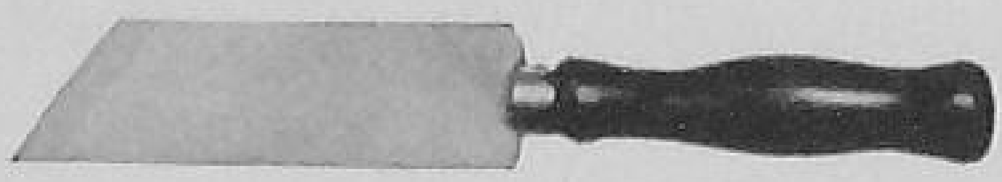
important that a smooth and uniform movement be maintained with a medium and uniform downward pressure. The amount of pressure, forward writing movement, and degree of heat required may be found by tests on pieces of scrap leather before the operation is tried on the project. Do not try to write on pebbled or embossed leather as the writing will be ragged and will "take" only on the higher surfaces.

41. Edge skive leather pieces.

Edge skiving is a method of reducing the thickness of leather. This operation is employed when two or more pieces of leather are to be laced together. Thus the laced edges of the finished article will not be too thick and bulky.

Lay the outside piece of the wallet grain side down on the cutting board. The edge to be skived should be parallel and directly above the edge of the

Bevel point skiving knife. Round handle. Used for skiving and edge trimming.



Skiving knife. This knife is especially designed for skiving.

FIG. 48.

cutting board. Grasp the skiving knife (see Fig. 48) in the right hand and place the blade flat on the flesh side of the leather. The center of the beveled cutting edge of the knife should be directly over the leather edge to be skived (see Fig. 49). Slightly lift the handle of the knife and tilt the cutting edge slightly downward by twisting the right hand to the right. Place the fingers of the left hand against the edge of the blade of the skiving knife (see Fig. 49). Cut a wedge-shaped piece of leather approximately $\frac{1}{4}''$ to $\frac{3}{8}''$ wide from the edge of the piece by pushing and pulling the knife with the right hand, while applying a sidewise pressure against the blade with the fingers of the left hand. Cut from left to right. *Do not* cut entirely through the leather edge to the grain side. The tapered cut should be from one-half to three-quarters the thickness of the leather. Be sure

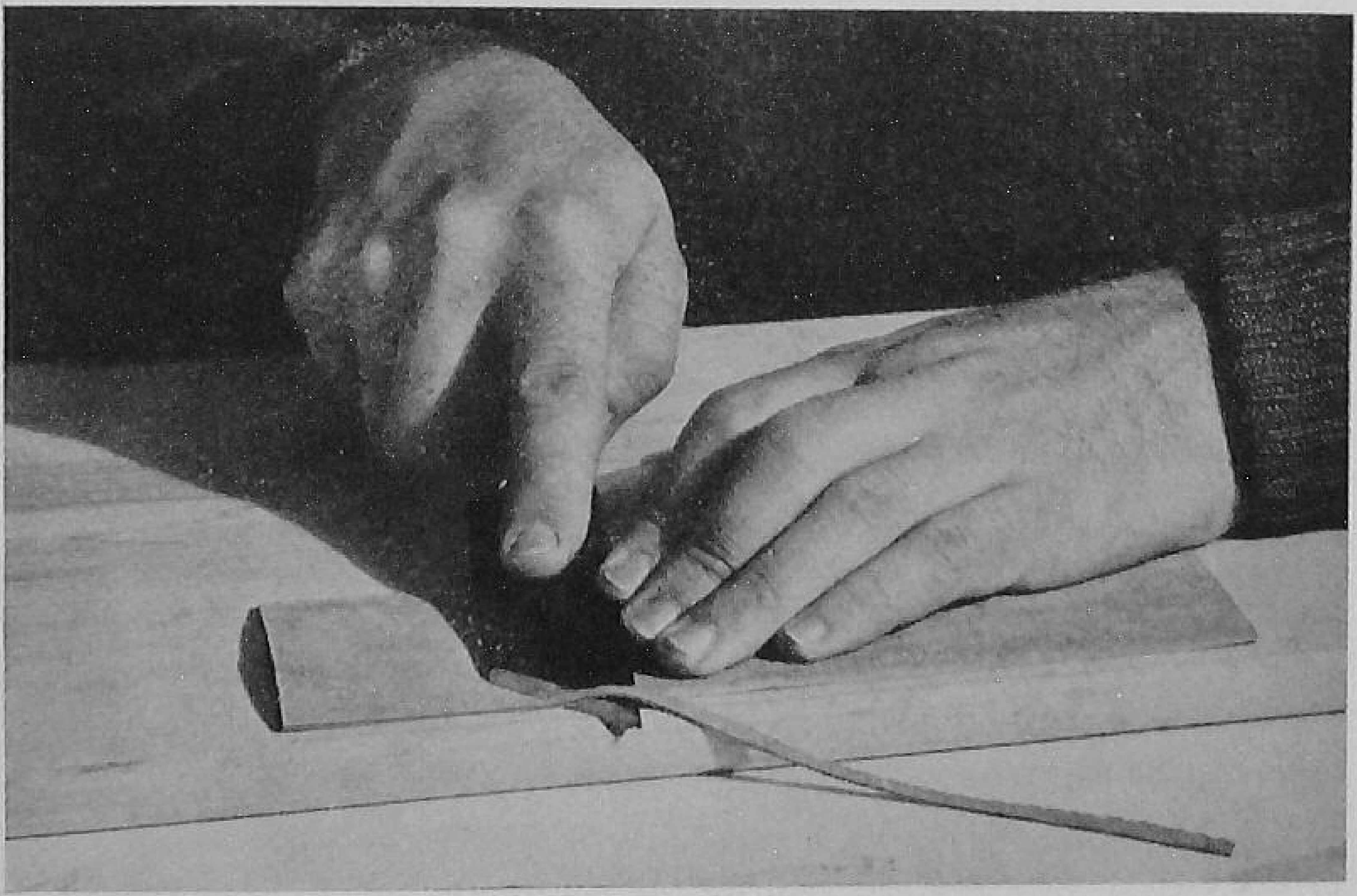


FIG. 49.

that the skiving knife is sharpened to a razor-like edge. Skive all edges which are to be laced.

42. Line outside piece of wallet.

The flesh side of leather is generally lined with a thinner leather when two finished surfaces are desired. These lining leathers are usually light-weight calfskins or sheepskin skivers. They come in colors which match the tooling leathers and have approximately the same number of square feet per skin.

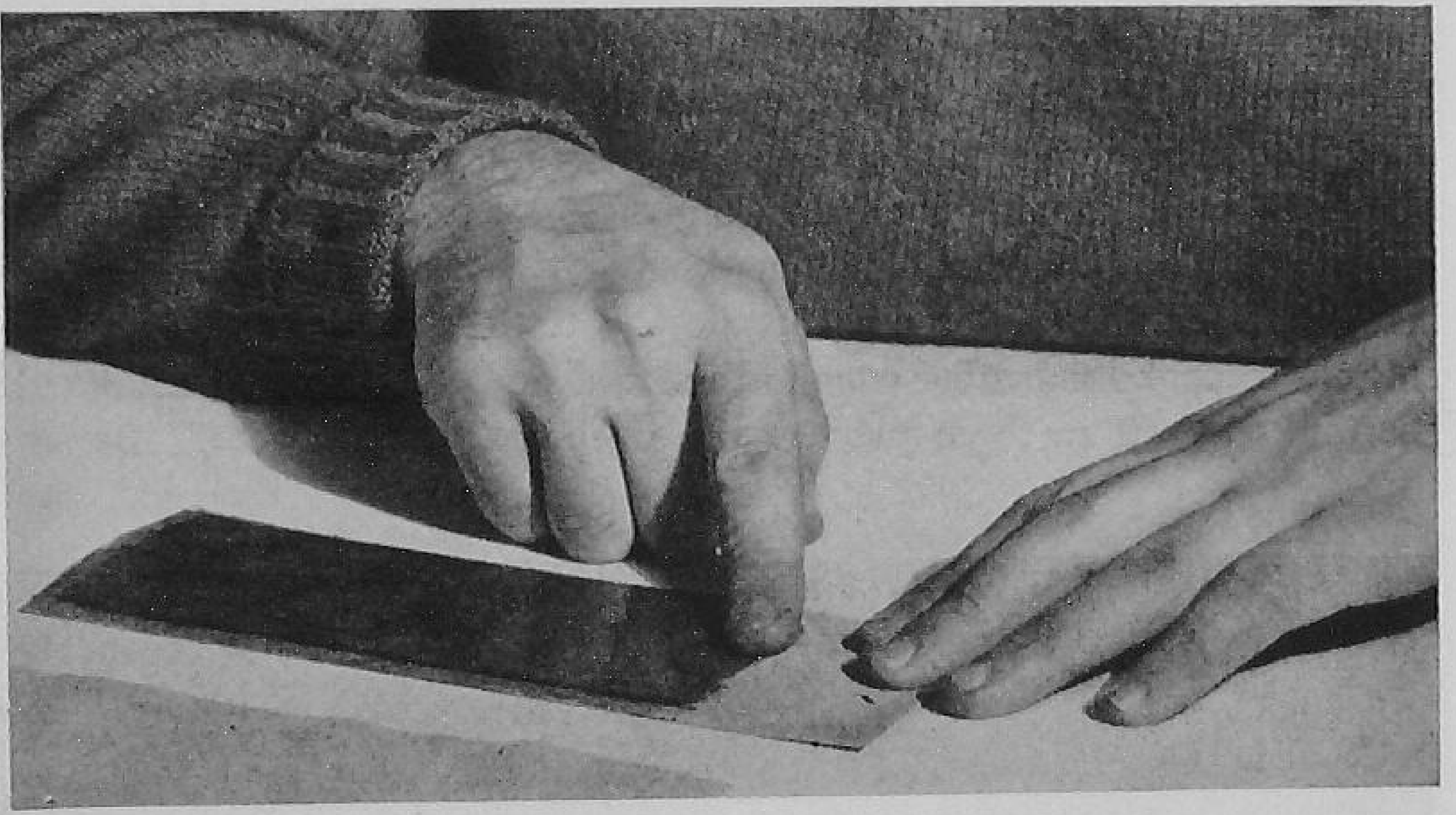


FIG. 50.

Cut a piece of lining calf or sheepskin skiver to fit the outside piece of the wallet (follow the same operations described in Step 3, Chapter I, or Step 16, Chapter II).

Pour some rubber or leather cement on the flesh side of both pieces of leather. Use a wooden tongue blade or stiff bristle brush to spread the cement evenly. Good results may be obtained by rubbing the cement into the leather with the fingers (see Fig. 50). When the cement has become tacky, place the two glued surfaces together. Half fold the leather (see Fig. 51) and smooth out wrinkles by running the thumb from the center to the edges. Lay the top fold flat as shown in Fig. 52 and repeat the smoothing operation. If the leather is not half folded when smoothing,

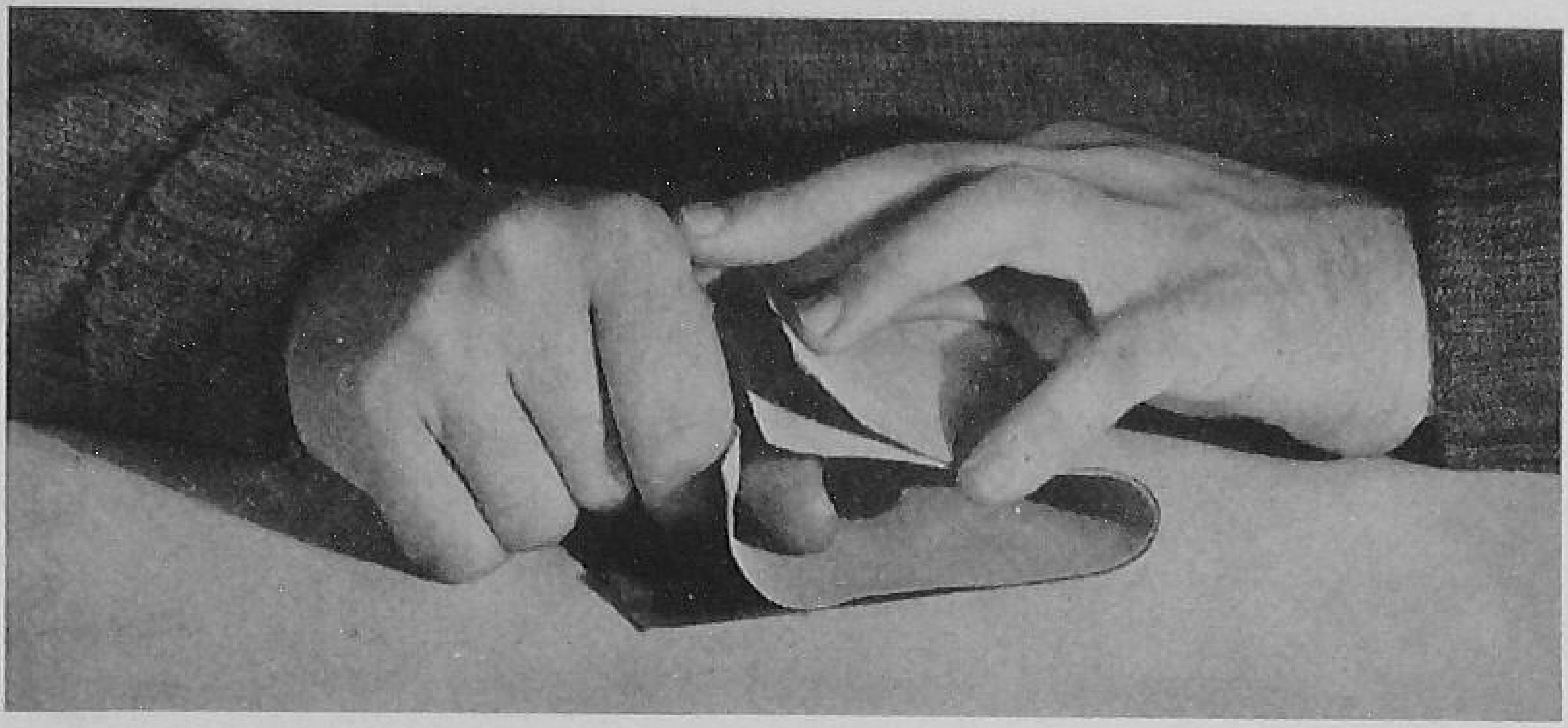


FIG. 51.

wrinkles will appear at the fold. Be sure to keep the hands clean and do not get any excess cement on the finished surfaces of the leather.

Some leathercraftsmen cut the lining slightly larger than the piece to be lined. The edges are then trimmed with a knife or shears when the cement has set.

The inside piece of leather for the wallet may also be lined.

FIG. 52.

43. *Lay out center lines for lacing holes* (see Step 21, Chapter II).
44. *Lay out center points of lacing holes on center lines* (see Step 22, Chapter II).
45. *Punch the lacing holes* (see Step 23, Chapter II).

It will be noticed that the outside piece of the wallet is slightly longer than the inside piece. This provides extra leather for the outside of the

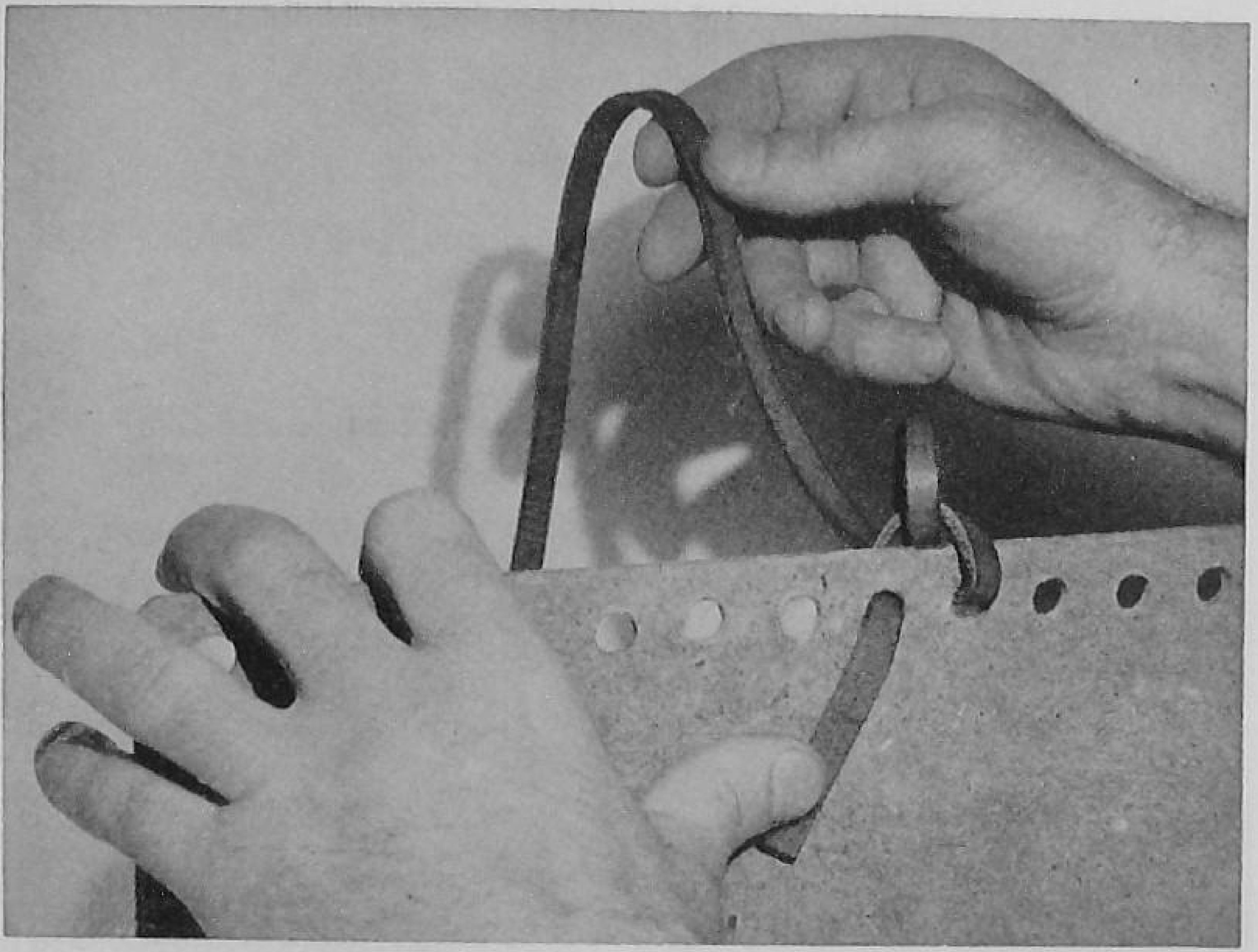


Fig. 53.

fold.[1] The same number of holes must be punched around the fold but the spacing of the holes must be slightly different. This may be accomplished by spacing the holes slightly further apart around the fold on the outside piece. It may also be accomplished by folding the wallet in a manner similar to that shown in Fig. 51 and punching the holes around the fold.

46. *Lace the wallet using the double-loop stitch.*

The double-loop or double layover stitch is a type of knotted lacing

[1] When assembling the parts for punching, be sure that the two ends of the inside piece are cemented to the ends of the outside piece. In order to accomplish this, the cementing must be done in a partially folded position. The bottom edge may also be cemented if desired.

which makes a heavier edge than the single loop stitch and wears extremely well. When using this type of stitch, measure the length of the edges to be laced and multiply the length by eight. This will give the proper amount of lacing for the project.

Hold the wallet in the left hand with the decorated side toward you. Start the lace in the center of one end of the wallet and lace from left to right as follows:

A. The first two steps in making this stitch are exactly the same as for the single-loop stitch. Review A and B and Figures 34 and 35 in Step 27, Chapter II.

B. It will be noticed that there are two loops (see Fig. 35). With the right hand, pull on the right-hand loop. This will draw the left-hand or first loop tightly against the edge of the leather. Pull on the end of the lacing to reduce the second loop in size (see Fig. 53) but do not pull it too tight.

C. Bring the lacing across the top of the loop, from back to front, and

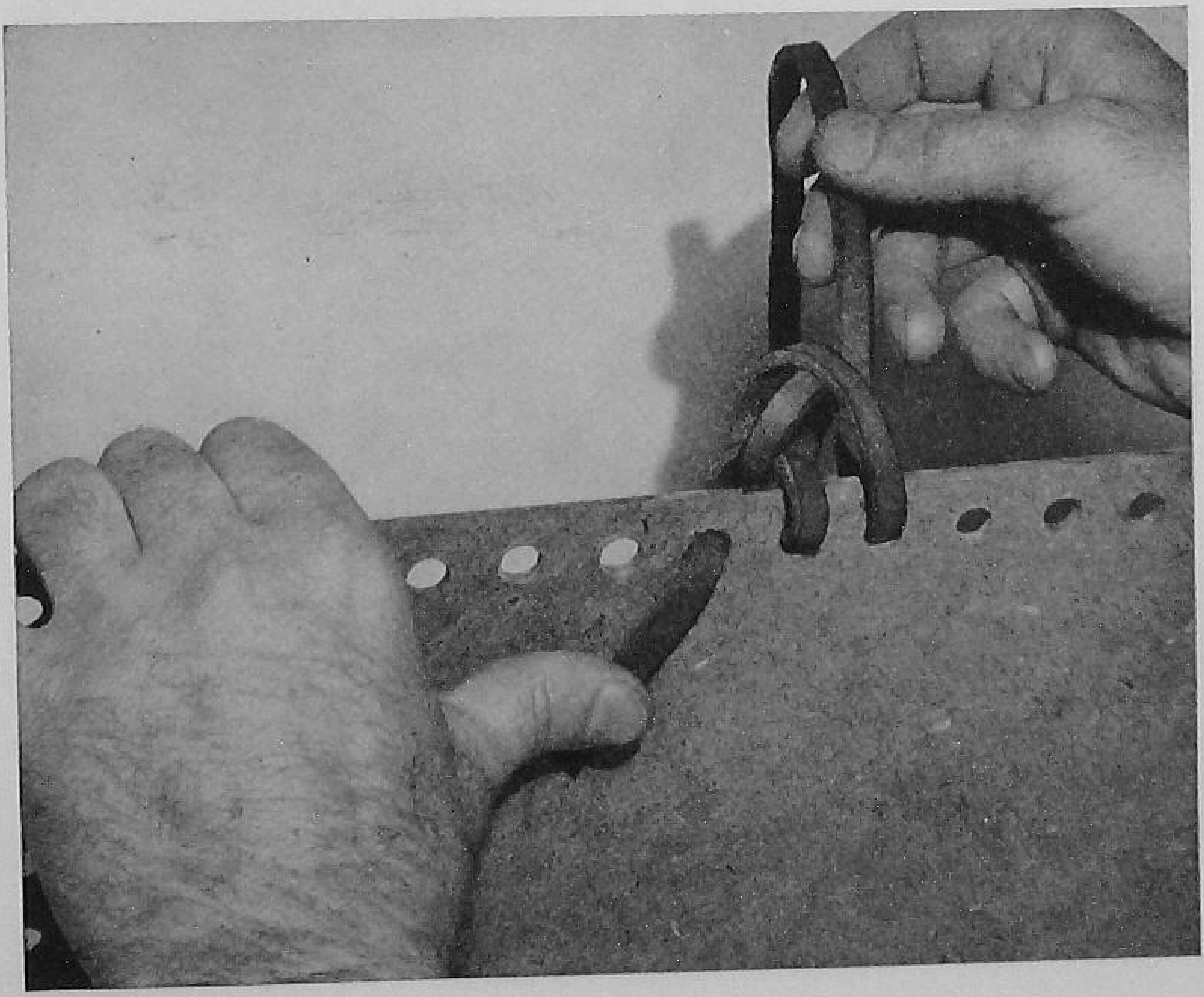


FIG. 54.

FIG. 55.

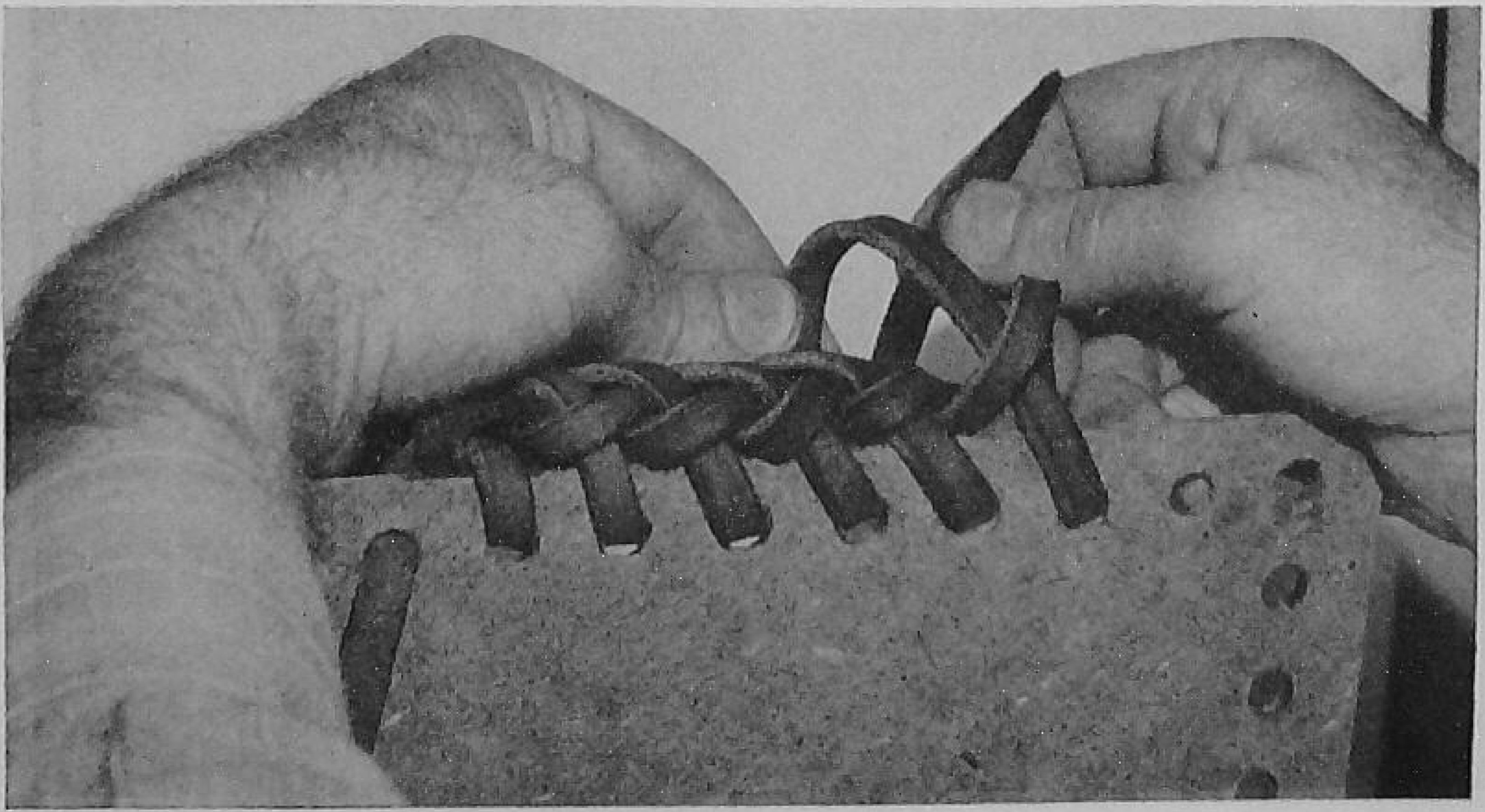


FIG. 56.

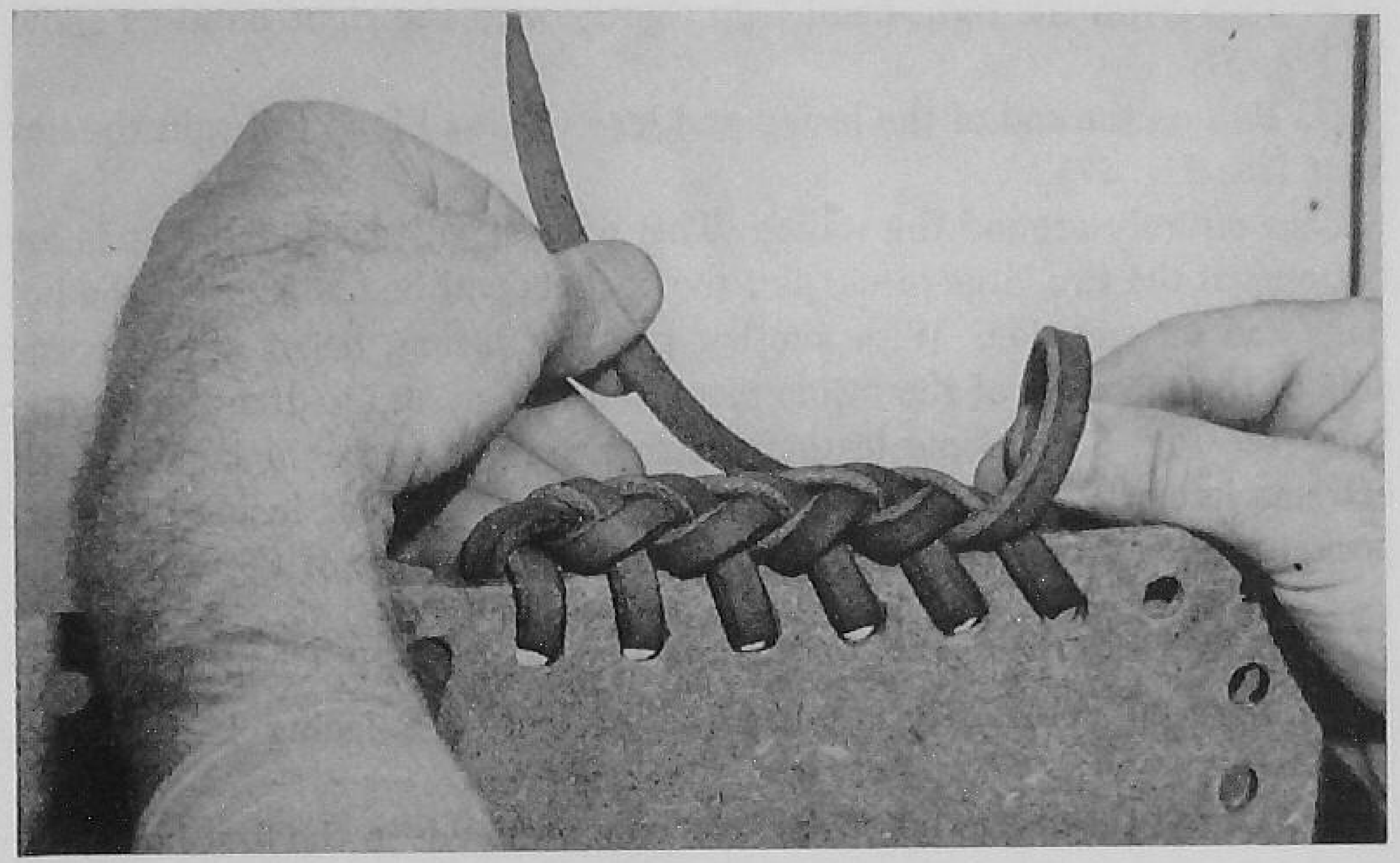


FIG. 57.

insert it from front to back through the next lacing hole (see Fig. 54). It will be noticed that the two loops cross each other.

D. Again bring the lacing across the top of the project from back to front. Insert it *under* the crossed loops as shown in Fig. 55.

E. Pull down the left-hand loop tightly with the left hand as shown in Fig. 56.

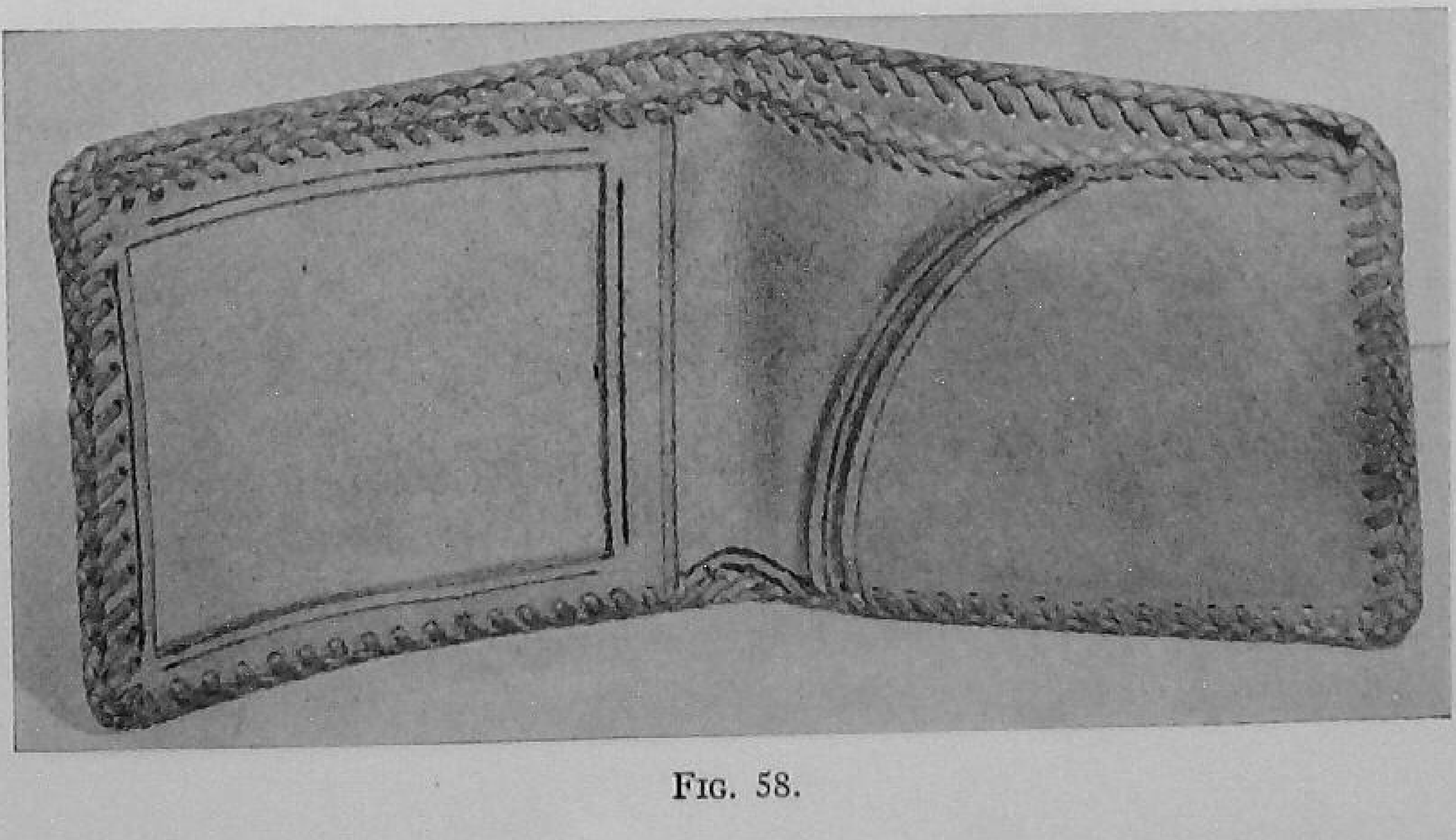


FIG. 58.

F. Pull down the right-hand loop tightly with the right hand as shown in Fig. 57.

G. Pull on the end of the lacing and leave a small loop to begin the next knot (see Fig. 57).

Lace entirely around the wallet. This will fasten together the ends and bottoms of the two large pieces and the pockets will be fastened on the bottoms and on one side. With another piece of lacing, begin at the corner hole of the top edge of the inside piece and lace across to the other corner hole (see Fig. 58). Some leathercraftsmen prefer to begin lacing at the extreme left of the inside piece. Lace across top edge of inside piece and pockets and continue clockwise around the outside edge of the wallet.

47. Join or finish the double-loop stitch (review Step 29, Chapter II).

After lacing completely around the project, the lacing is joined as follows:

A. Pull out the short end of the lace which was left in the first hole when you began to lace. Make a final stitch in this hole. (This is the same as *A*, Step 29, Chapter II.)

B. With the right hand, pull the short end of the lace down and out of its loop (see Fig. 59), leaving the loop intact.

C. Bring the end of the lacing up from the back and *through* the loop (see Fig. 60).

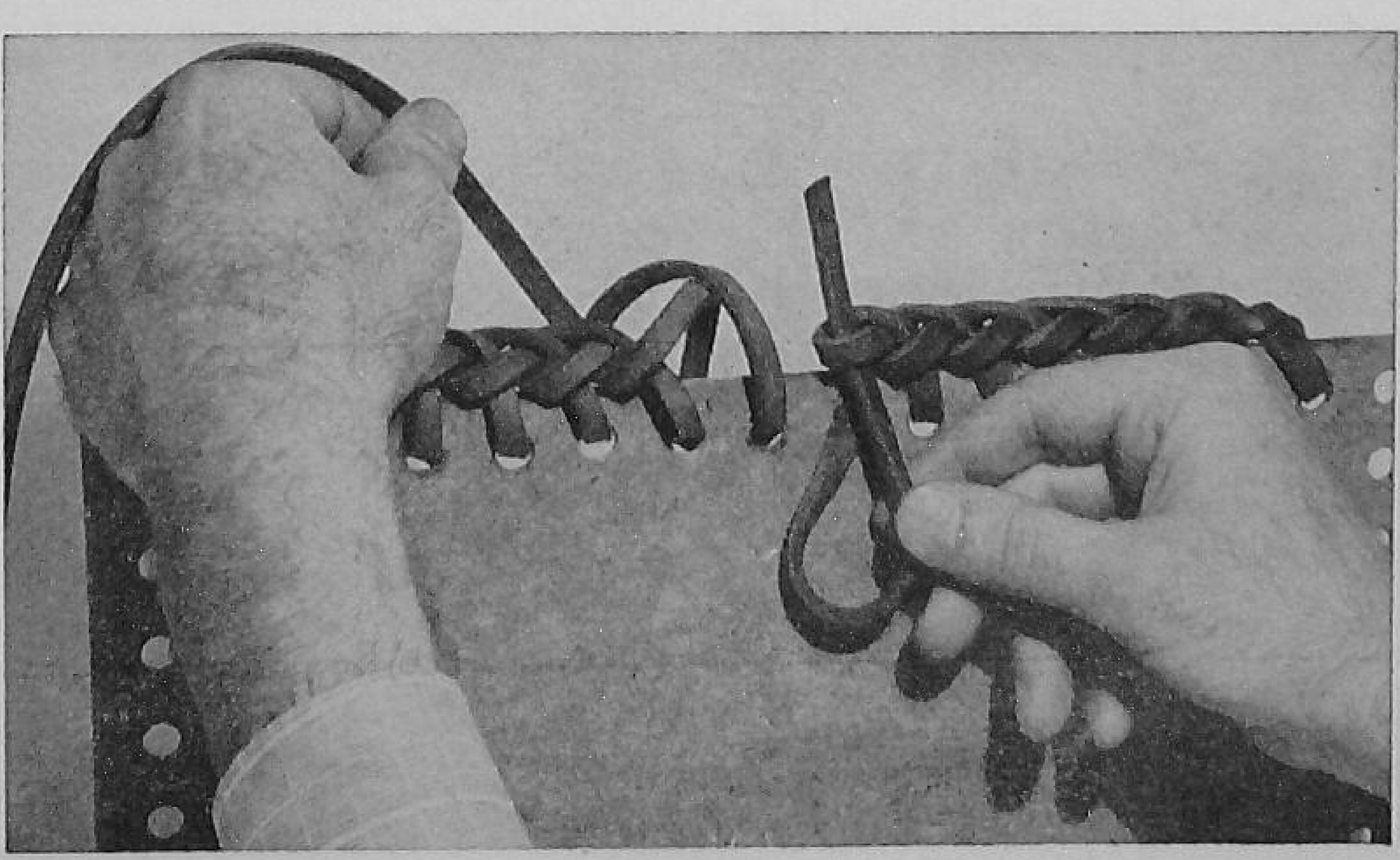


FIG. 59.

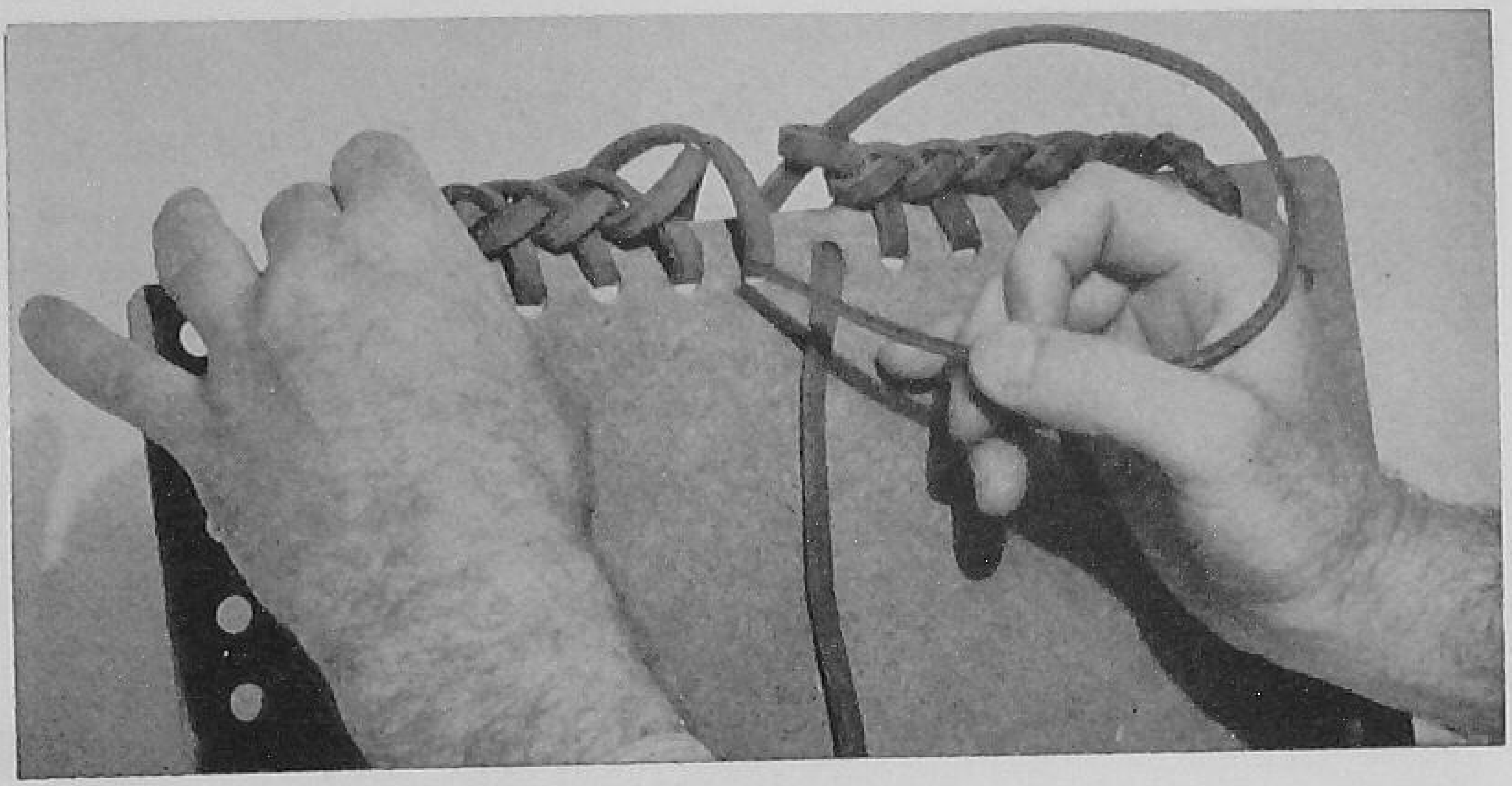


Fig. 60.

D. Complete the last stitch as usual by inserting the lacing *under* the crossed loops as indicated in Fig. 60.

E. Again bring the lacing from back to front and *down through the loop* as shown in Fig. 61. Tighten the loops.

F. Insert the two ends of the lacing in the last hole and between the two pieces of leather as described in *D* and *E*, Step 29, Chapter II. The lacing

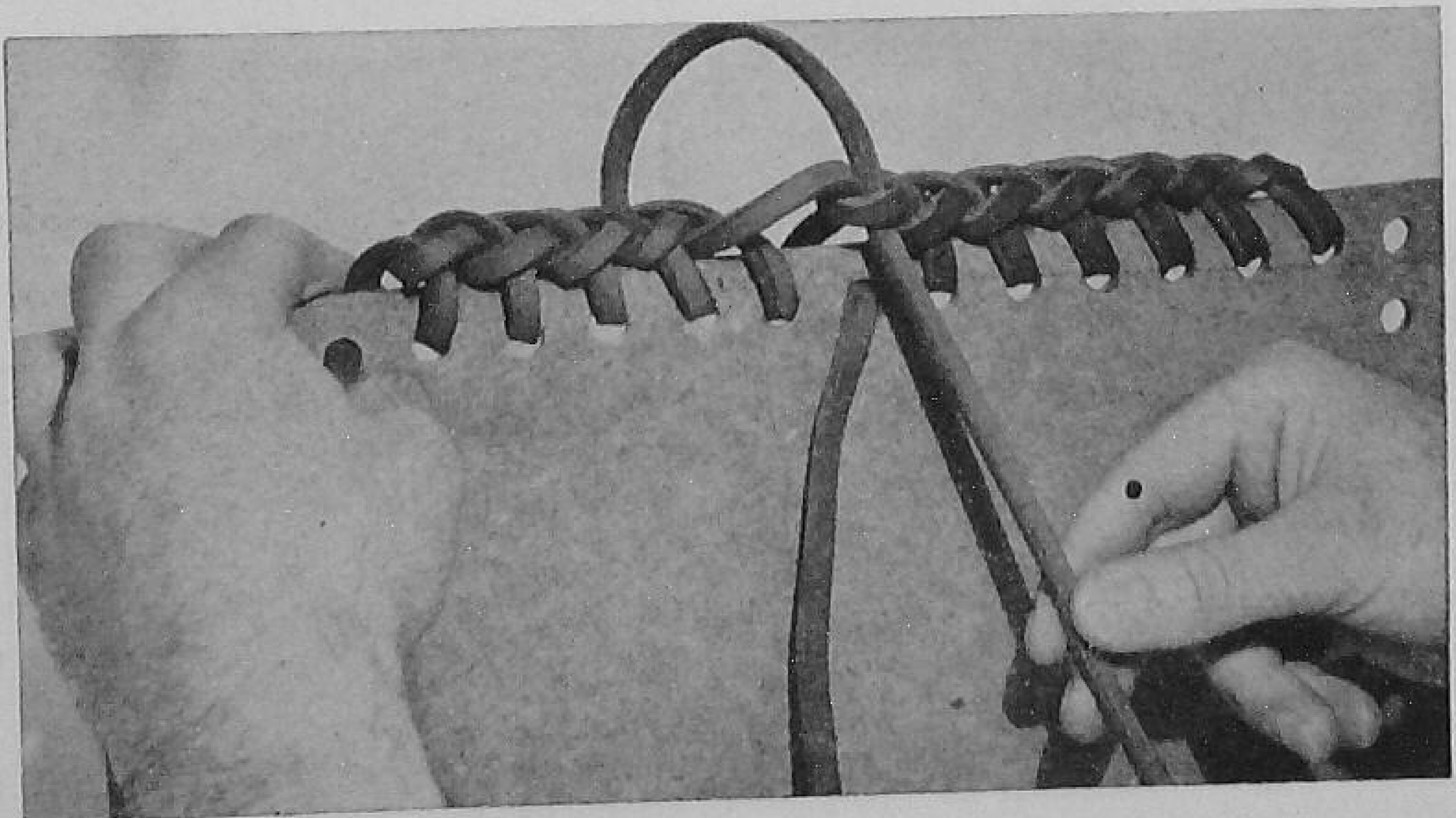


Fig. 61.

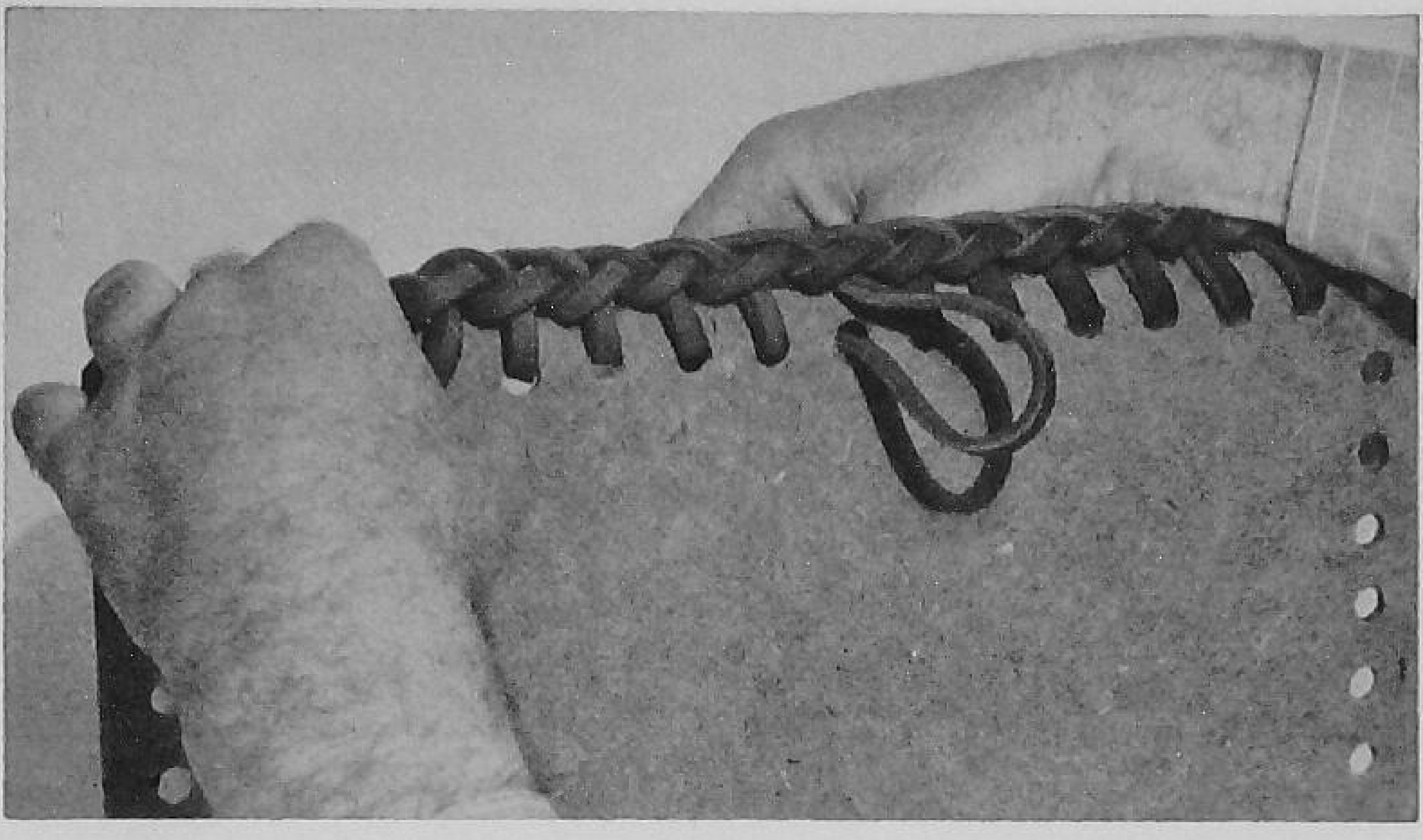


FIG. 62.

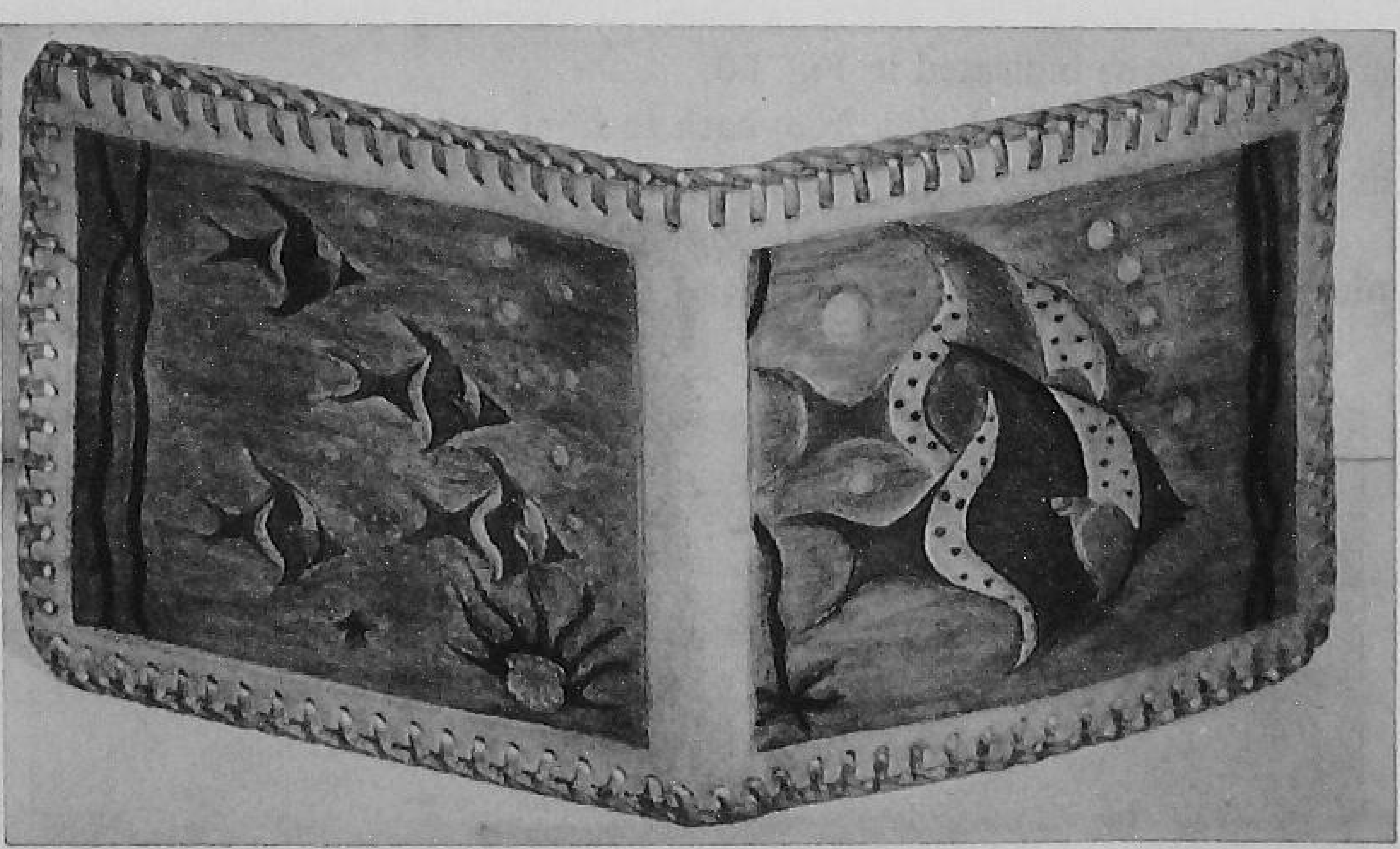


FIG. 63.

is shown being finished in Fig. 62. The finished appearance of this kind of stitch can be observed on the stained wallet illustrated in Fig. 63.[2]

If a celluloid window is desired (see Fig. 58) cut a piece to size from sheet celluloid and slip it in the pocket. It may be glued to the pocket prior to the lacing if so desired. Celluloid card cases may be purchased which have a patented welded edge and are made stronger than the sheet celluloid.

48. *Clean the wallet with saddle soap as explained in Step 12, Chapter I.* Apply a coat of Johnson's paste wax and polish.

The accompanying table might be helpful in selecting the proper size punch for the width of lace to be used.

Lace Width	*Punch Size*
5/64″ goatskin	No. 00
3/32″ "	No. 0
1/8″ "	No. 1
3/16″ "	No. 1
3/16″ Florentine	No. 0
3/8″ "	No. 1

Chapter IV

HOW TO MAKE A PAIR OF STAINED LEATHER BOOK ENDS

Leather book ends are usually very popular projects. They are comparatively simple to make and are very useful. The process consists of lacing variously shaped pieces of leather over correspondingly shaped pieces of sheet metal. Figure 64 presents a few suggested book-end plans. Many different designs, sizes, and shapes may be developed, however, by the leathercraftsman.

49. *Select and trace a suitable design* (see Steps 1 and 2, Chapter I).
50. *Lay out and cut sheet metal book-end forms.*

Lay out the shape of the book end (see A, Fig. 64) on a piece of heavy wrapping paper or cardboard. Using this as a pattern, lay out the shape of the book ends on a piece of 18- or 20-gage sheet metal with a scratch awl. Cut out the metal shapes with tin snips as follows:

When making straight cuts, the straight snips or combination snips may be used. Grasp the snips in the right hand and the narrowest part of the sheet metal in the left. Open the blades and insert the sheet as far as possible into the jaws. Place the upper edge of the cutting blade exactly on the line of the cut, and proceed as with a pair of ordinary scissors. If the snips have a tendency to drift to either side of the line, tip them in the direction of the drift. This will tend to draw the tips of the blades toward the line. When approaching a line marking the end of a cut, do not allow the tips of the blades to extend beyond the line. This will prevent cutting into the remaining stock.

To make outside curved or circular cuts, the curved blade or hawksbill snips are used. Hold the metal in the left hand and the snips in the right, cut on curved line, removing the waste material in one piece. When making an inside curved cut make a hole with a hollow punch or drill in the center of the piece near the outline. Insert the blade from the under side of the metal and cut to the outline as before.[1]

[1] Robert L. Thompson, *et al.*, *The Home Mechanics Handbook*, New York: D. Van Nostrand Company, Inc., 1945, pp. 300-301.

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51. *Cut leather to desired dimensions* (review Step 3, Chapter I, and Step 16, Chapter II).

Two pieces of natural calfskin must be cut for each book end. It is necessary that they be larger than the sheet metal blanks to provide for the lacing and the bend in the metal. The outside or front piece should be ¼″ larger around all edges except the bottom edge which should extend

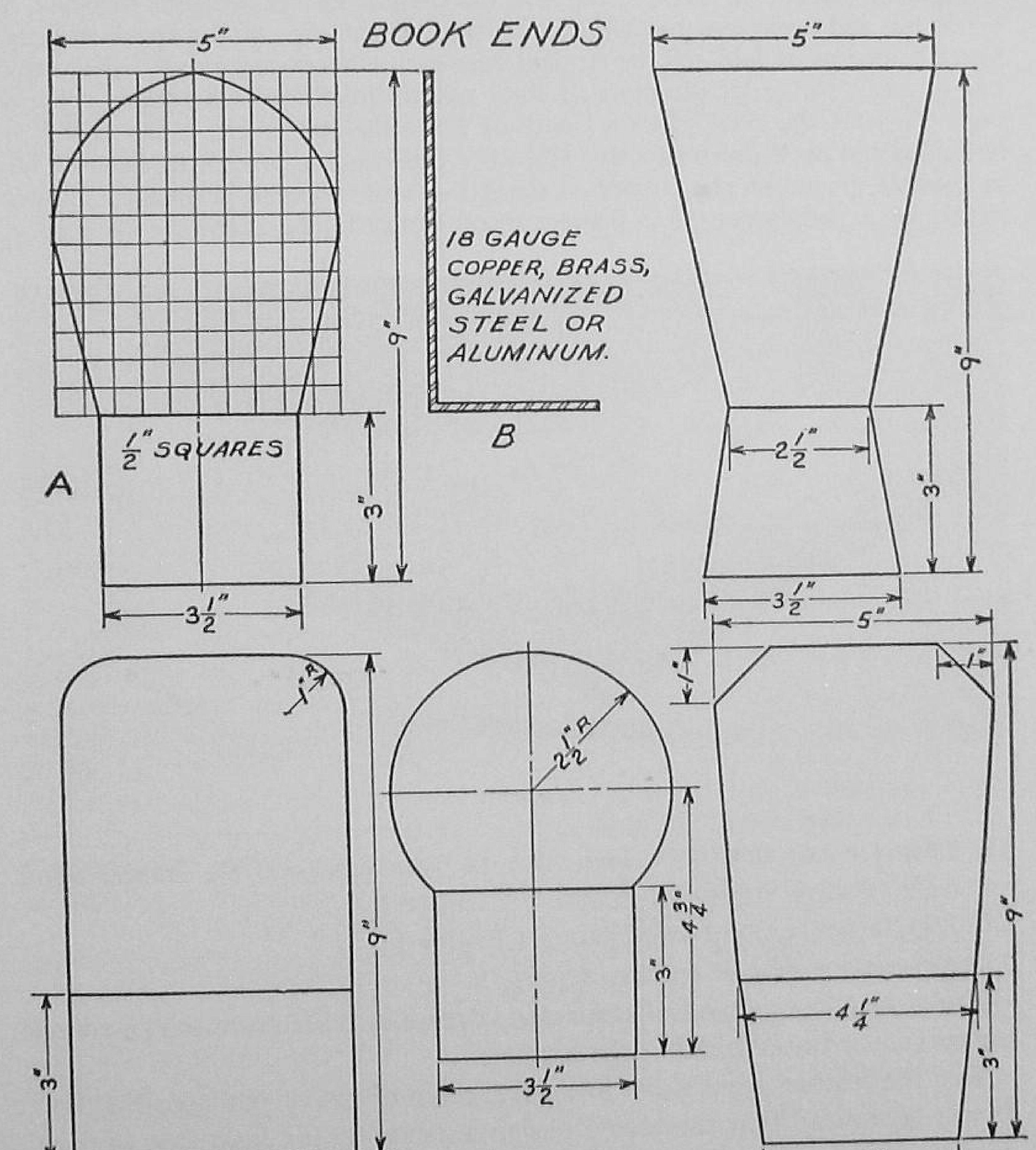


Fig. 64.

½″ below the bottom edge of the metal blank. The inside or back piece should be the same as the front piece with one exception. It should be ¼″ shorter as the concave fold requires less leather than the convex fold.

52. *Bend sheet metal book-end forms* (see B, Fig. 64).

The sheet metal forms should be bent as follows:

To bend a piece of sheet metal to a right angle, clamp the sheet between a bench top and a piece of hardwood, with the straight edge of the bench directly beneath the line of fold and the straight edge of the hardwood directly above the line of fold. Never hit the piece of sheet metal directly with a mallet or hammer. To start the bend, place a length of 2 x 4 the full length of the metal to be folded and press down smartly. Continue this bending process by hand as far as possible, pound on the outside of the 2 x 4 until the bend is finished. Blows should be angled downward to prevent metal from slipping under the clamps.[2]

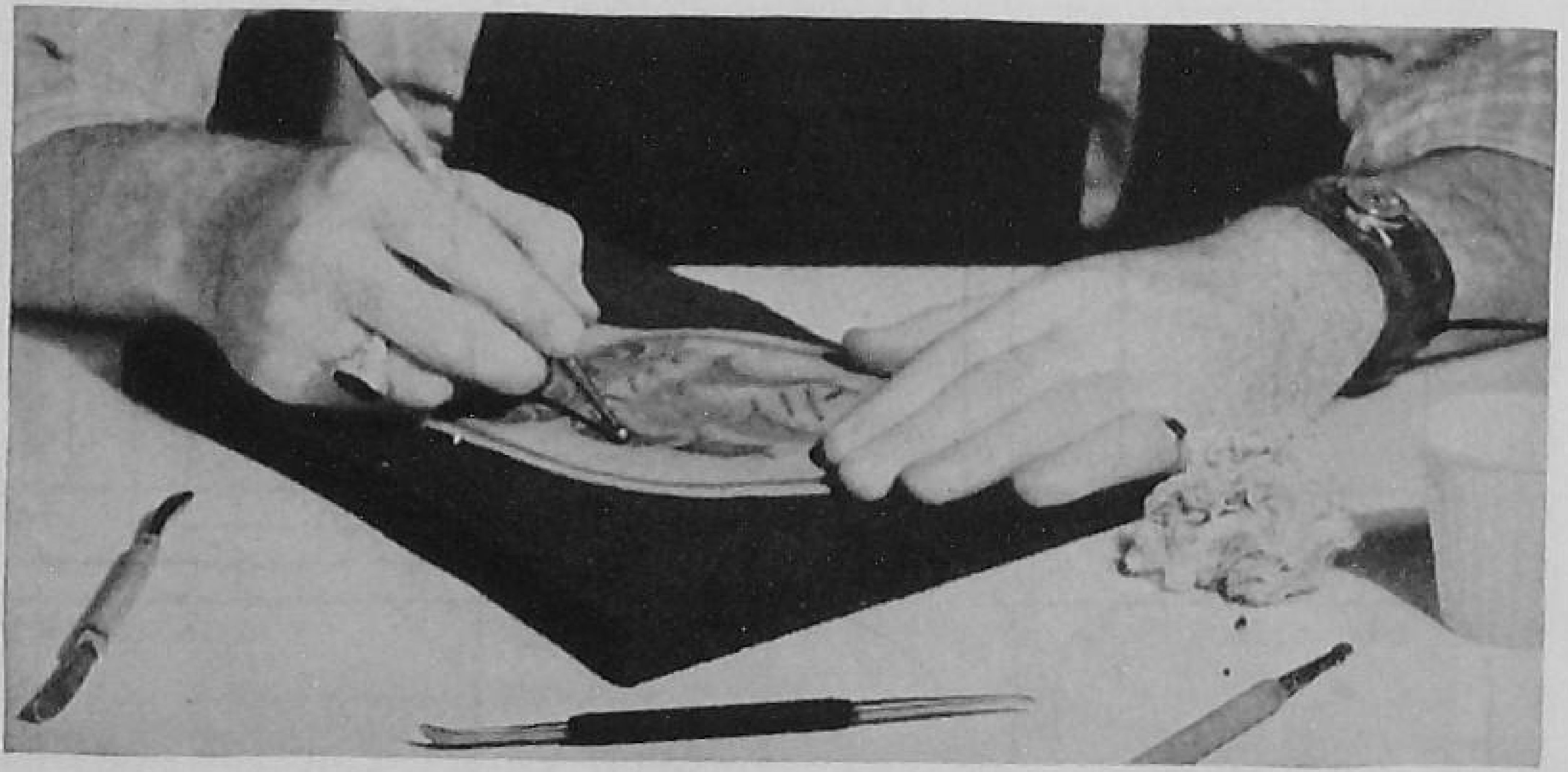


FIG. 65.

53. *Transfer and tool the design to both front pieces of the leather book ends* (review Steps 4, 5, 6 and 7, Chapter I).
54. *Stipple background* (see Step 8, Chapter I).
55. *Repoussé model or emboss design.*

Embossing is a method of raising the design in relief from the surrounding surface or background of the leather.

Lay the leather grain side down on a piece of heavy felt (see Fig. 65). It will be noticed that the tooled design appears on the flesh side as darkened lines and will outline the areas which are to be raised. With the spoon

[2] *Ibid.*, p. 308.

end of the modeler or with the ball end modeling tool (see Fig. 65), press and smooth that part of the design, which is to be raised, down into the felt (see Fig. 65). Use the Deer Foot modeling tool (see tool at extreme right, Fig. 65) if square corners or sharp angles are encountered. It may be necessary to dampen and retool the design lightly from time to time. Some leathercraftsmen use the palm of the hand in place of the felt. Others lay the leather flesh side down on a surface and place the middle fingers of the left hand on either side of the design to be raised. The modeling tool is placed under the leather and the design is pushed up between the fingers.

56. *Back-up or fill the cavities of the embossed design with small pieces of sheet cork.*

Embossed designs should be filled to prevent them from being pushed back or from "falling." Many different materials may be used. A thick flour and water paste, a glue and sawdust mixture, plaster of Paris and lacquer, plastic wood, kapok and sweet oil, ground or shredded leather and leather cement, and sheet cork, are only a few of the fillers which are used by leathercraftsmen.

Most embossed leathers are lined. The design, on a project which is not to be lined, should not be raised too high as it will not "stand up" for long. It is unnecessary to line the leather book ends as the sheet metal inserts provide the necessary covering for the filled cavities.

Trace the design on a piece of sheet cork. With a knife or shears, cut out pieces from the sheet cork which have the same shape but are slightly smaller than the cavities (see Fig. 66). Apply leather cement to one side of the cork pieces and to the cavities. Place the cork pieces in the corresponding cavities and smooth down with the spoon end of the modeler as shown in Fig. 66.

57. *Lay out and punch lacing holes* (see Steps 21, 22 and 23, Chapter II. Review particularly Step 45, Chapter III).

As 3/8" Florentine lace is going to be used to lace the project, punch a hole at every other dot made by the number six spacing wheel. Some leathercraftsmen lay out the center-to-center distance of the holes equal to the width of the Florentine lace. A small hole is generally recommended for this type of lace (see chart, Step 48, Chapter II).

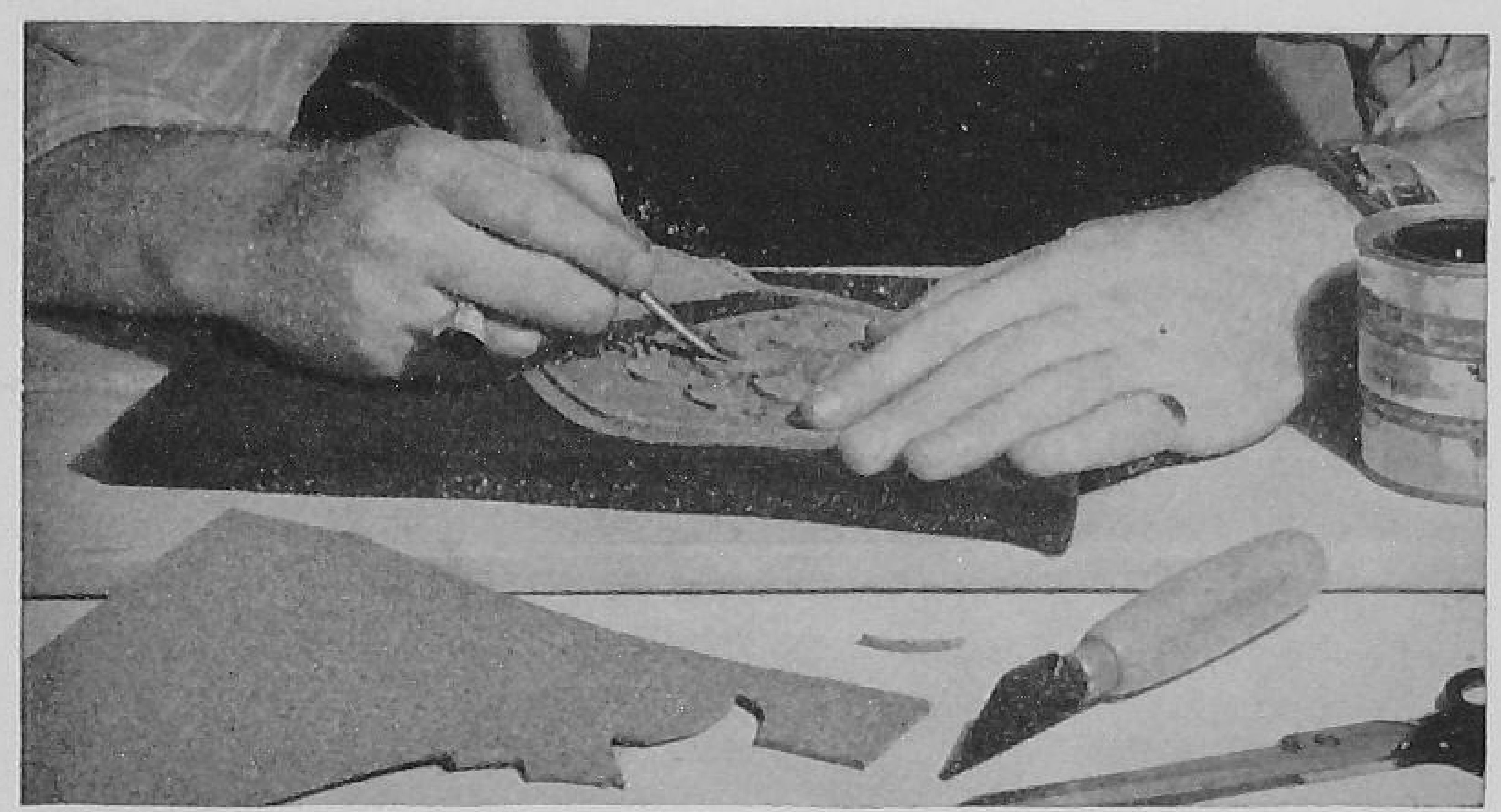


FIG. 66.

58. Clean surface of embossed leather with oxalic acid solution ($C_2H_2O_4$).

As a general rule, saddle soap should be used to clean colored leather (see Step 12, Chapter I), and a weak solution of oxalic acid should be used to clean natural leathers which are to be stained. Some leathercraftsmen use various weak solutions of hydrochloric acid for cleaning. Others use very weak solutions of sodium carbonate, caustic potash or caustic soda, followed by a weak sulfuric acid solution as a neutralizer.

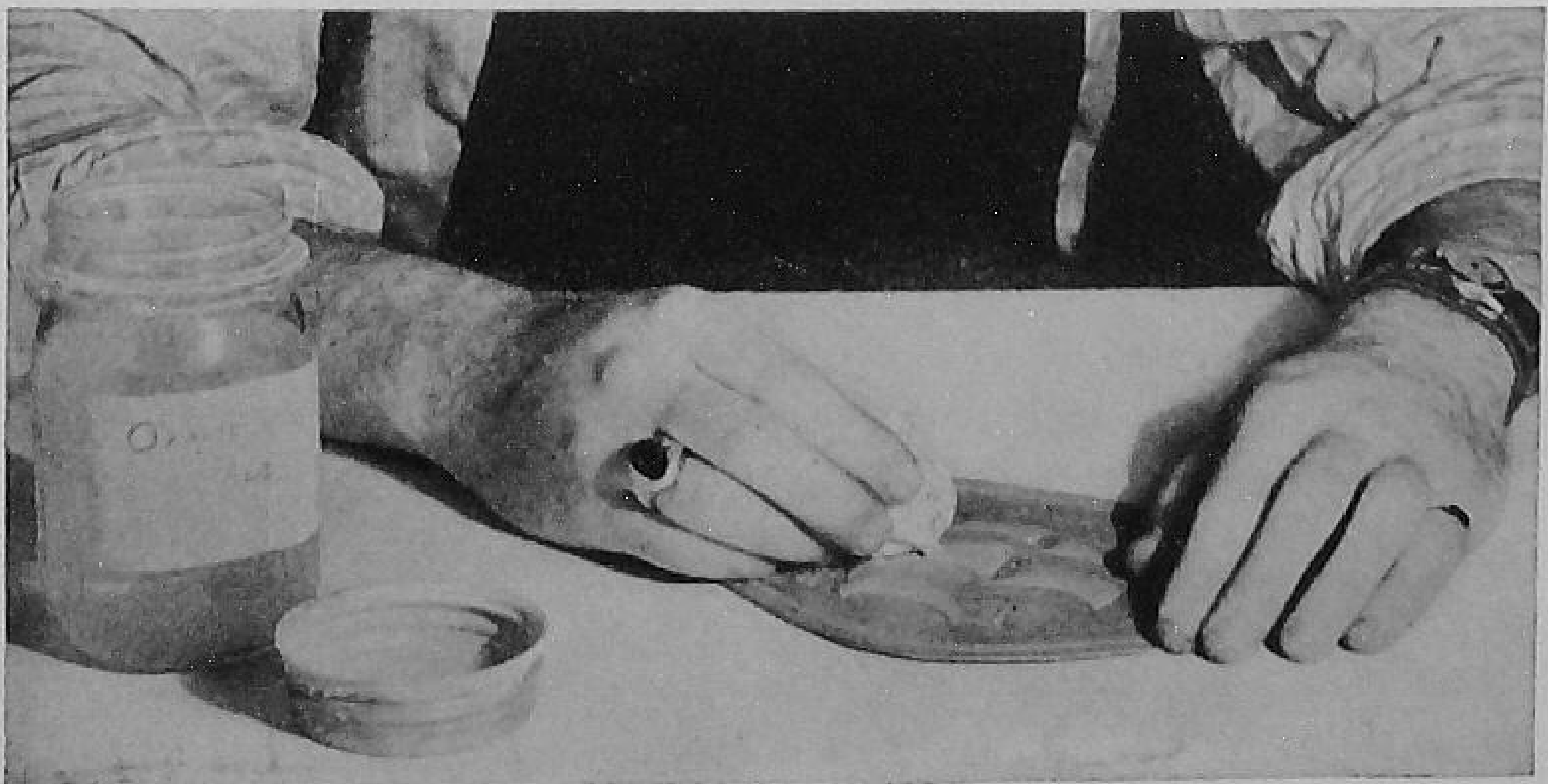


FIG. 67.

Make an oxalic acid solution by dissolving two teaspoonfuls of oxalic crystals in a pint of water. Apply the solution firmly and evenly over the entire surface of the leather with a piece of cotton waste or sponge (see Fig. 67) and allow the leather to dry. It is only necessary to spread the solution over the surface. Do not rub. The oxalic acid solution acts as a bleaching agent.

59. Bring out the embossed design in color by using leather dyes.

Many leathercraftsmen complete the project and do the staining or enameling last. This is highly recommended to beginners as the sweat and oil from the hands have a tendency to stain or darken the leather project during the lacing operation.

Leather dyes and waterproof inks are transparent and should be used only on natural skins. If they are used on colored leathers they will not be very effective. Leather dyes may be purchased in powder or liquid forms. Some powders are soluble in alcohol and others in water. They are usually sold in small paper packages which will make approximately one pint of concentrated dye. They are available in practically all colors and may be mixed to produce other colors. Never mix an alcohol-soluble dye with a water-soluble dye, however. It is advisable to mix the powders according to the directions given on the package. Some leathercraftsmen add a few drops of vinegar to the solution to help "set" the dye.

Liquid dyes are usually sold in 2-oz. bottles and may be obtained in most colors.

Coloring tooled leather with waterproof inks is increasing in popularity. The inks penetrate deeply into the grain of the leather, are quite permanent, and have bright values. Waterproof inks are usually sold in ¾-oz. bottles and may be obtained in a wide range of colors. They may be used full strength or may be diluted with water to produce lighter tints. Different colors may be mixed to produce other colors. After the ink has been applied and allowed to dry, a beautiful luster may be obtained by polishing the leather with the palm of the hand.

When you are ready to dye the embossed leather book ends, dampen the surface slightly. This will prevent the rapid absorption of the dye by the leather and will have a tendency to prevent "streaking." Apply the dye (see Fig. 68) with a soft camel's-hair or red sable brush. It is advisable to try out the dye on a scrap piece of leather before you color the project. Always rinse the brush in alcohol and wipe dry before applying another

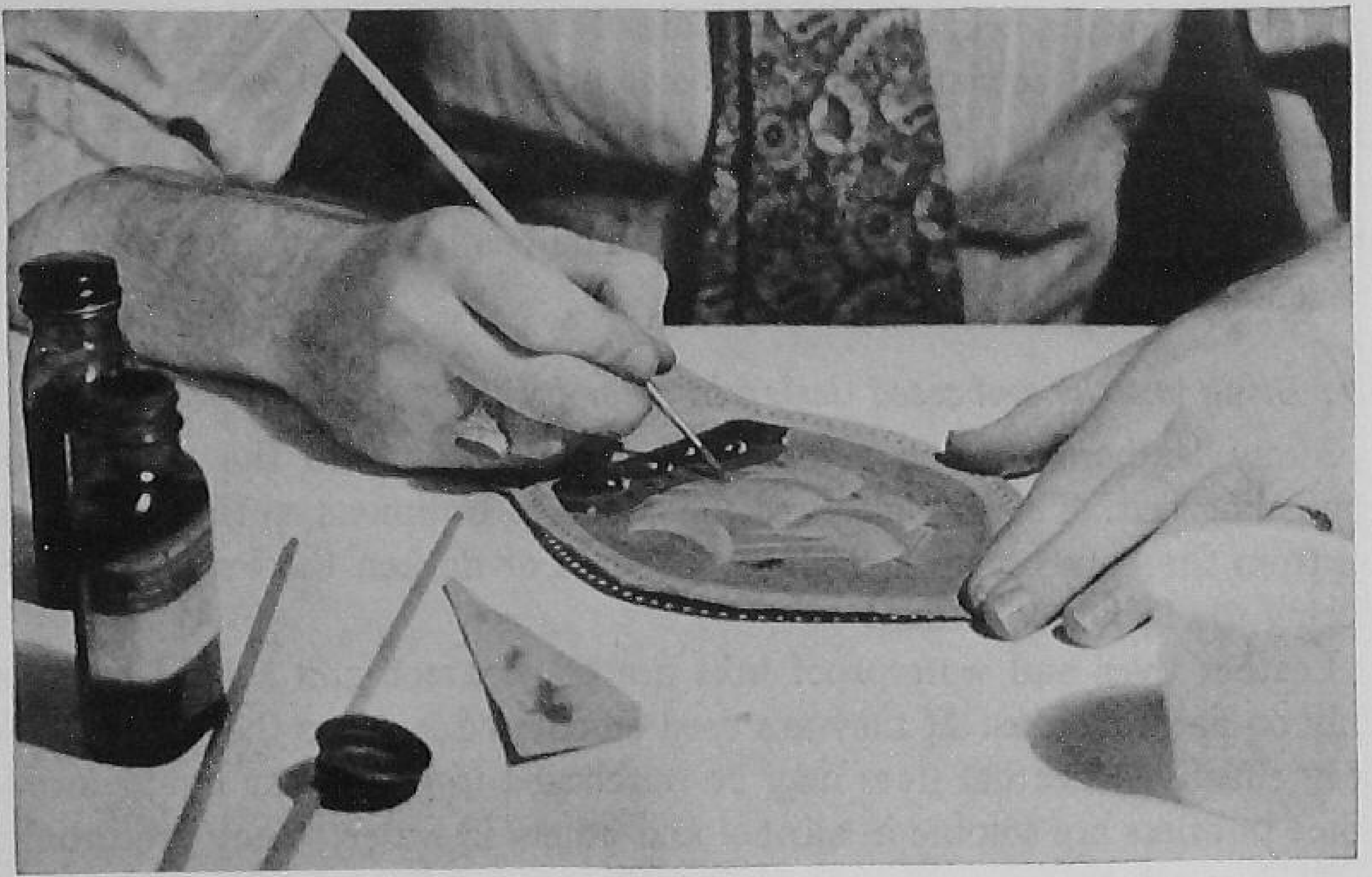


Fig. 68.

color. Several different sized brushes (see Fig. 68) should be on hand. Apply a coat of Johnson's paste wax and polish with a soft cloth.

60. Bring out the design in color by using leather enamels (optional).

Flexible enamels can be used on either natural or colored leathers with beautiful results. The enamels are usually sold in 2- or 4-oz. jars, are avail-

Fig. 69.

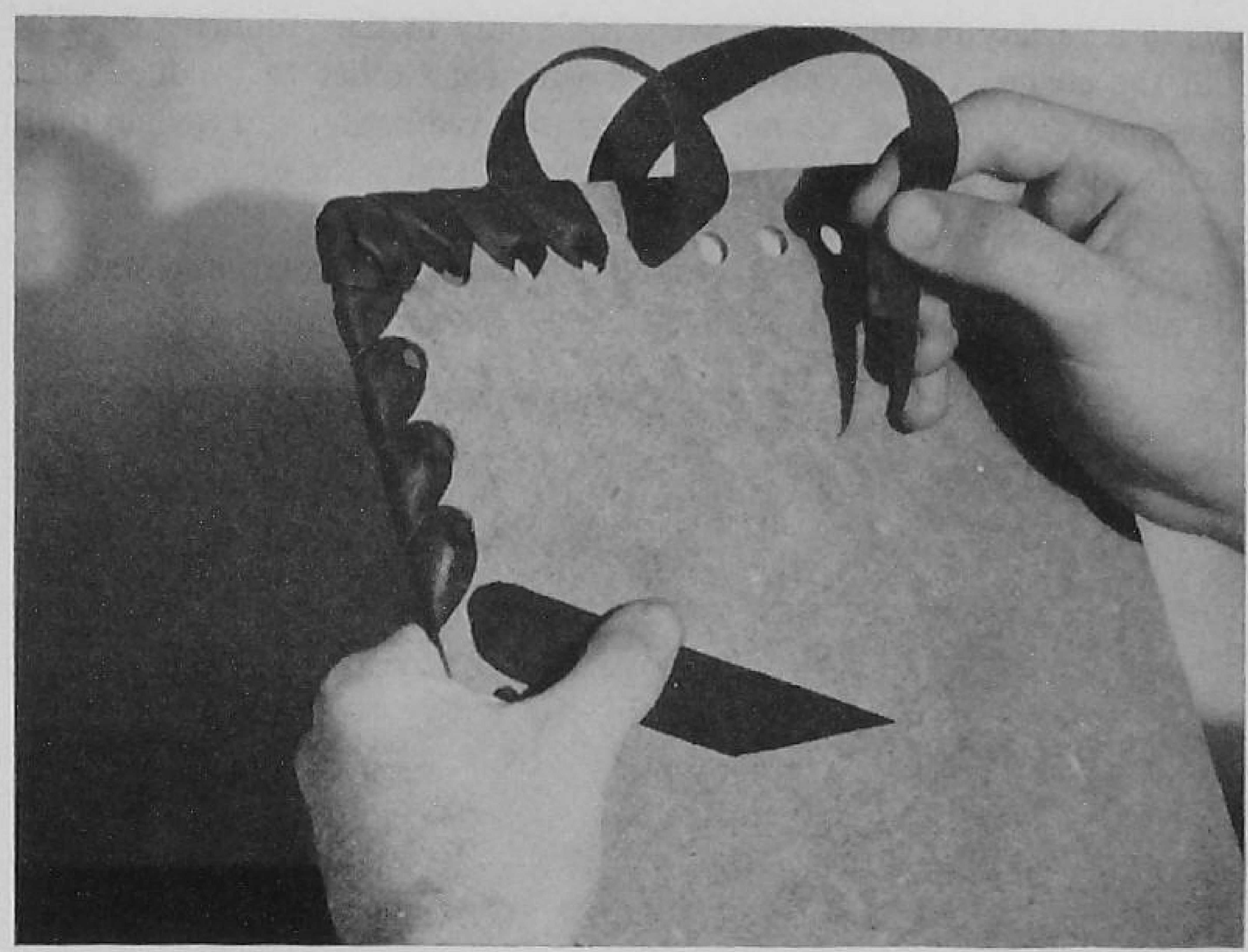


Fig. 70.

Fig. 71.

able in a variety of colors, and are soluble only in the "thinner" supplied with the enamel. They can be mixed with each other to produce other colors, are quick drying, do not crack or peel too badly, and remain quite flexible. Red Sable brushes should be used to apply the enamel as "thinner" will dissolve the settings of any ordinary brush.

Apply the enamel in much the same manner as you would any water or oil paint (see Fig. 69).

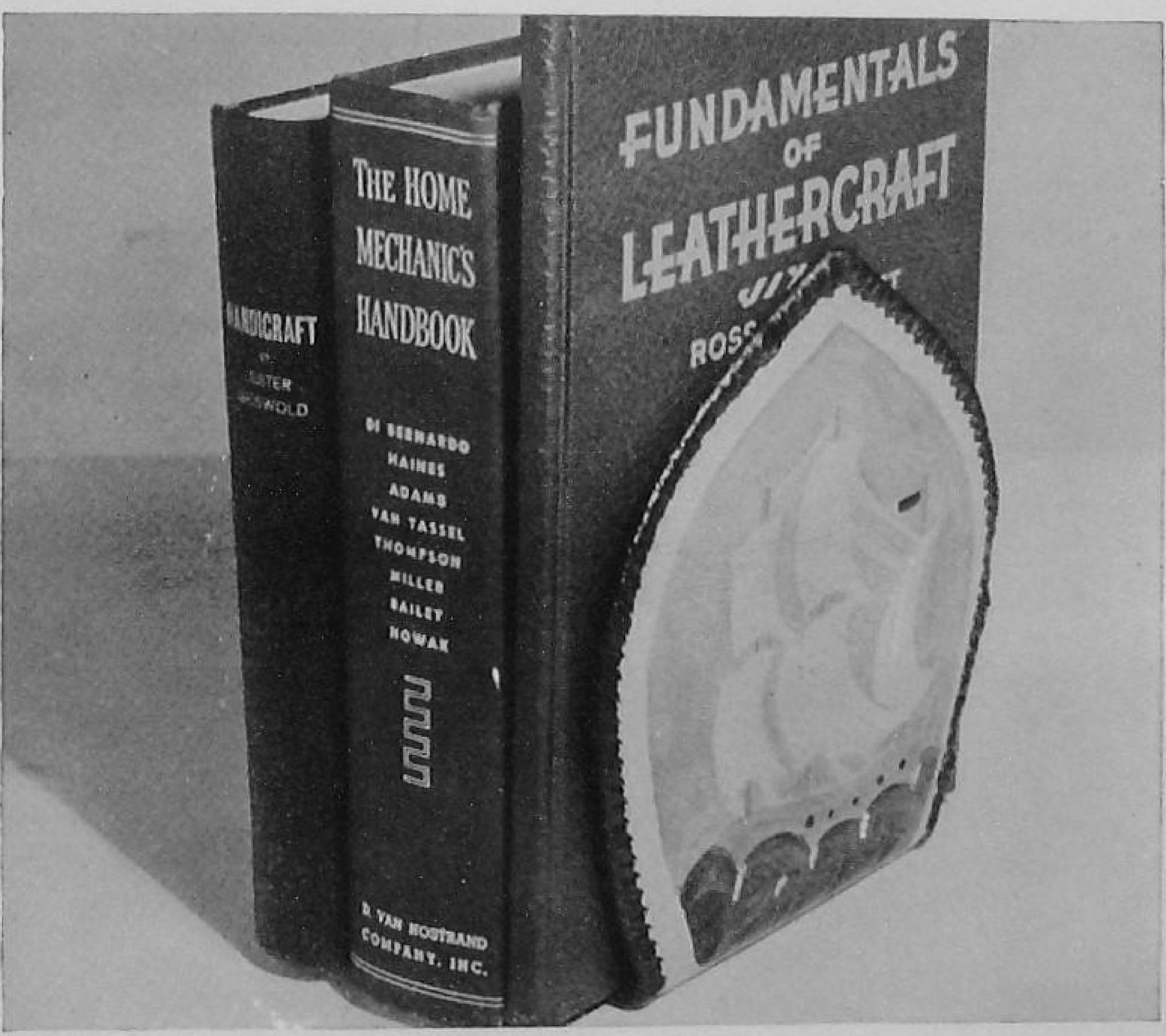


Fig. 72.

61. Lace edges of book ends with Florentine lace.

Florentine lace is made from kidskin and is very soft and pliable. It is obtainable in many different colors and is generally sold in two widths; 3/16″ and 3/8″.

A knotted edge is very seldom, if ever, made with Florentine lace. A simple over-and-over style of lacing is employed. Simply insert the lace in one hole, from front to back. Carry the lace over the top edge, from back

to front, and insert it in the next hole. Pull the loop tightly against the edge making sure the finished side of the lace is on top and is not twisted (see Fig. 70).

Place the two pieces of leather flesh side to flesh side. Begin the lace at the middle of the bottom as shown in Fig. 71. and lace to the fold. Temporarily fold the article and continue lacing to the tip point (Fig. 71).

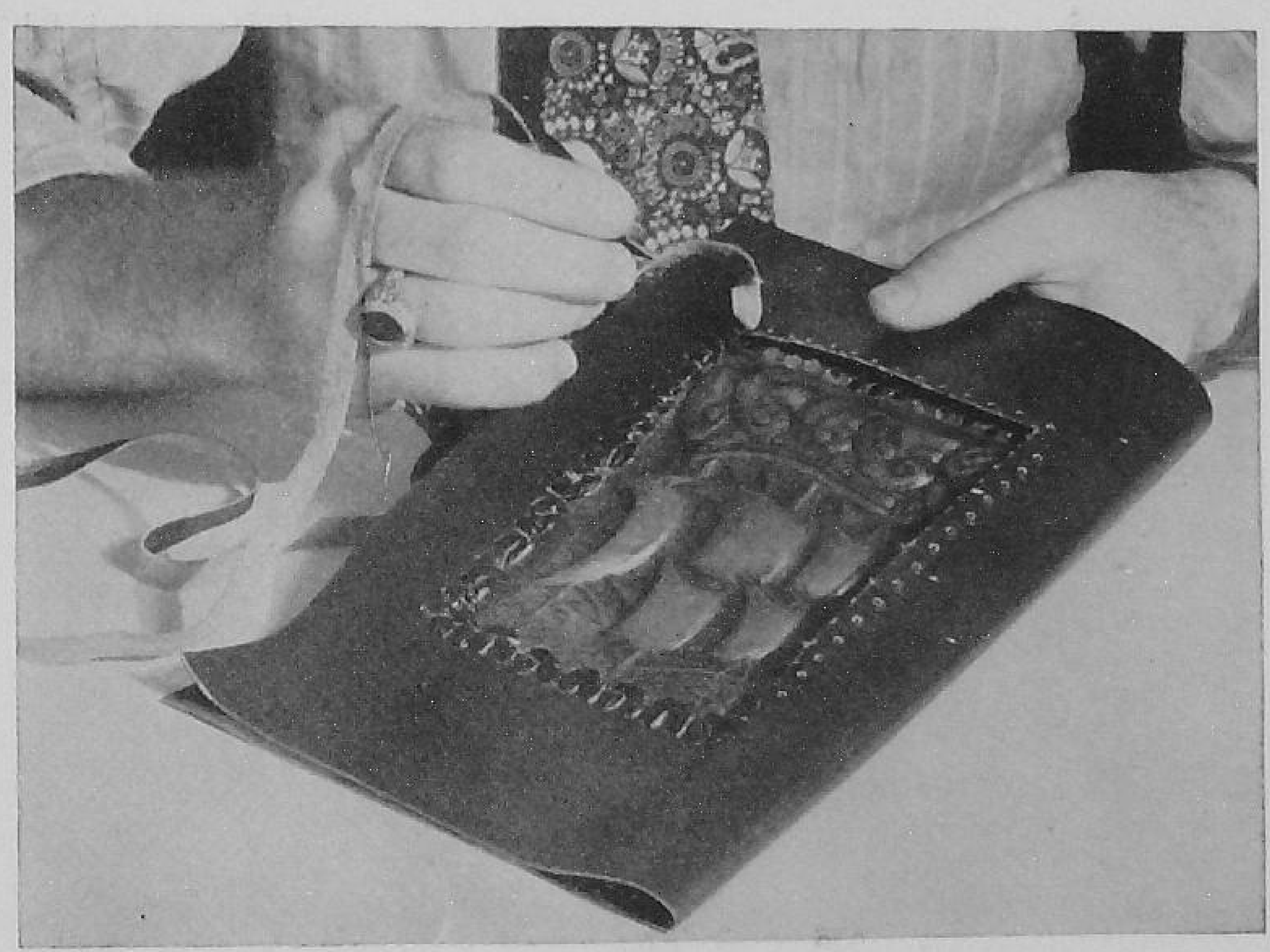


Fig. 73.

Place the metal insert between the two pieces of leather (see Fig. 71) and complete the lacing. The end of the lacing should be drawn under the first loop made, tightened, and trimmed even with a pair of shears.

Several pieces of sheet cork, cotton, or paper towels may be inserted with the sheet metal to give the leather a padded appearance (see Fig. 71). Clean leather with saddle soap (see Step 12, Chapter I), apply a coat of paste wax and polish. The finished book ends are shown in Fig. 72.

62. Repoussé a design in copper foil and insert it in leather (optional).

Copper and brass foil, 36 gage x 12″ wide, and weighing approximately 1 lb. to 4 sq. ft., may be purchased by the foot or pound. This very thin metal may be modeled with the same tools and in a manner similar to that

used with leather (see Step 55). Holes should be punched in the metal foil with a sheet metal punch to correspond with those punched in the leather. For an over-and-over edge treatment as illustrated in Fig. 73, the foil should be the same size as the section cut out of the leather. It will be noticed that three separate stitches are made into the corner and adjacent holes of the leather, which pass through only the corner hole of the foil.

Chapter V

HOW TO MAKE A SET OF FOUR BLOTTER CORNERS

Blotter corners are very popular leather projects and use a minimum amount of leather and lacing. As all four corners are alike it is usually necessary to decorate all of them in the same or similar manner. Thus identical operations and processes may be practiced on the same project. A desk set may contain four blotter corners, a blotter top, a writing folio, a pen wiper, and a calendar frame. A rocking blotter may be seen in the frontispiece.

63. *Select and trace a suitable design* (see Steps 1 and 2, Chapter I).
64. *Cut leather to desired dimensions* (review Step 3, Chapter I, and Step 16, Chapter II).

Four triangular pieces of tooling calfskin and four triangular pieces of lining leather are required.

65. *Transfer and tool the design to all four of the blotter corners* (review Steps 4, 5, 6, and 7, Chapter I).

Tool a double border, at least $\frac{3}{8}''$ to $\frac{1}{2}''$ in from the edge and approximately $\frac{1}{4}''$ wide, around the design.

66. *Stamp border around design.*

Many craftsmen prefer leather stamping to tooling. A wide variety of commercial stamps (see Fig. 74) offer many possibilities in design when used singly or in combination.

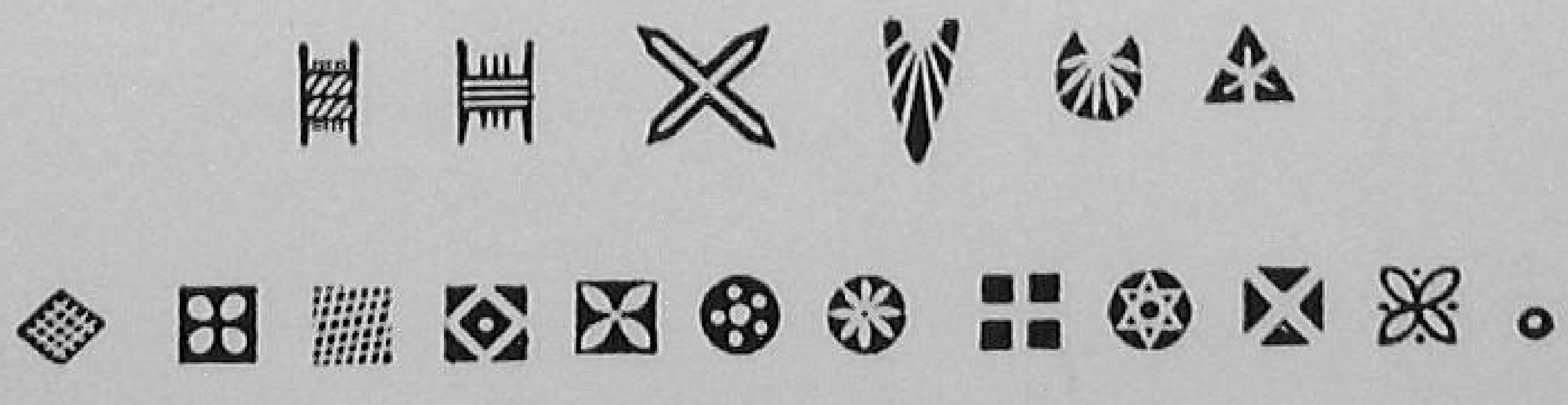


FIG. 74. Background stamps.

Metal stamps can be made from nails or small metal rods. The design being filed, drilled, or ground into the end of the rod.

Wooden stamps may be made from maple dowel rods with the design cut or carved into one end. Circular, square, or rectangular wooden blocks with the design carved on one side may also be used as stamps.

Dampen the leather and lay it flesh side down on a piece of hard wood or thick marble. Place the metal stamp at one corner of the tooled border. Tap the other end of the stamp with a mallet (see Fig. 75). Do not strike the stamp too hard as it is liable to break the surface of the leather and the uncolored interior will be revealed. Continue the stamping between the tooled lines on all pieces.

Extreme care should be taken when moving the stamp to a new position as this operation is done entirely by "eye" and the spacing around each stamped design should be uniform. A differently designed stamp may be used at the corners.

Make sure that the stamp is not tipped but is held in a perfectly vertical

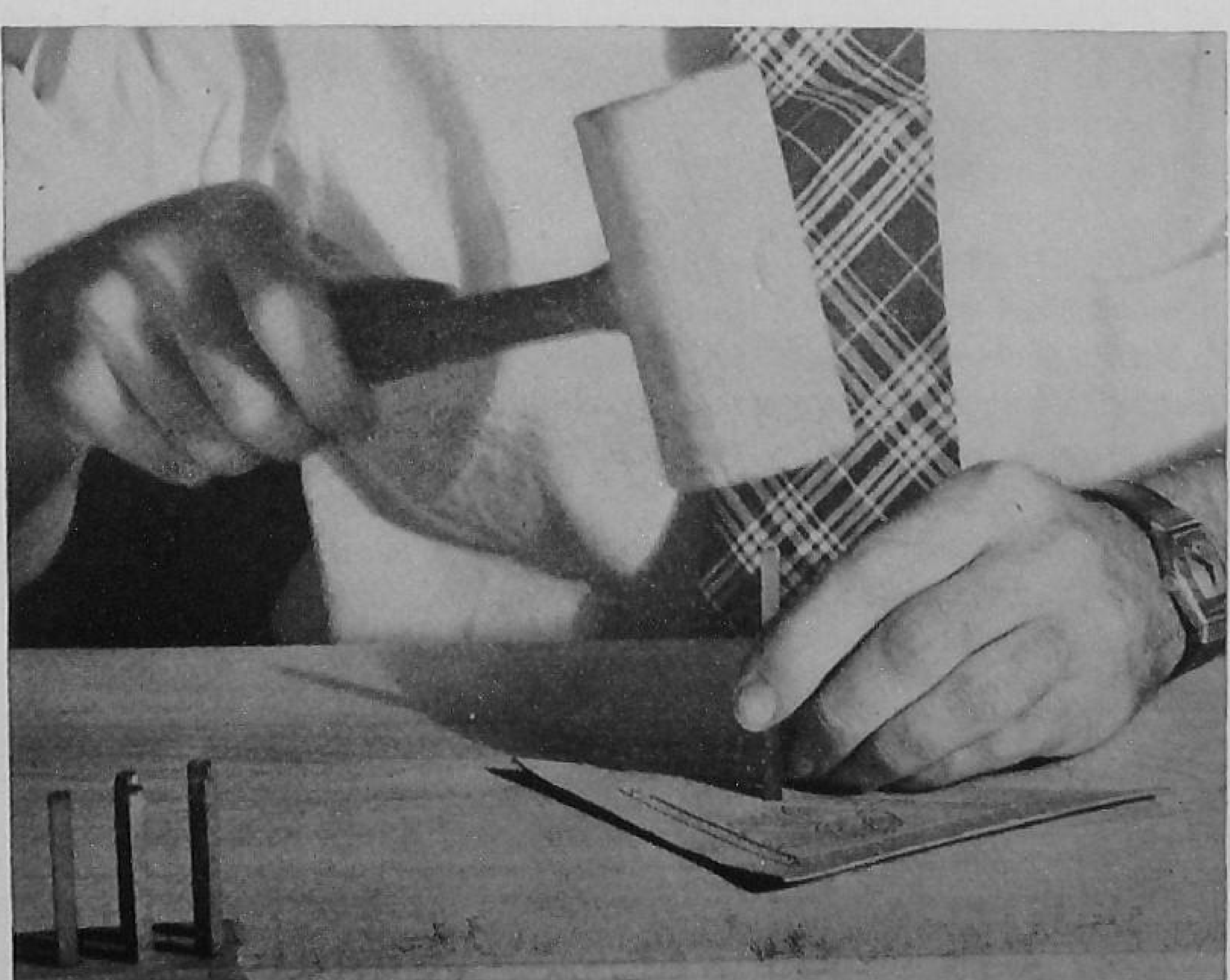


Fig. 75.

position. Strike each stamp only once. Use uniform blows. A uniform and consistent design will result.

Stamps may also be used to flatten the background of various designs with an over-all pattern.

67. Make border with embossing wheel (optional).

Embossing wheels are very useful for making border designs on leather projects. This tool consists of a handle with a carriage on the end which holds a small metal wheel. The wheel has a continuous design engraved around its edge and a variety of differently engraved wheels are available

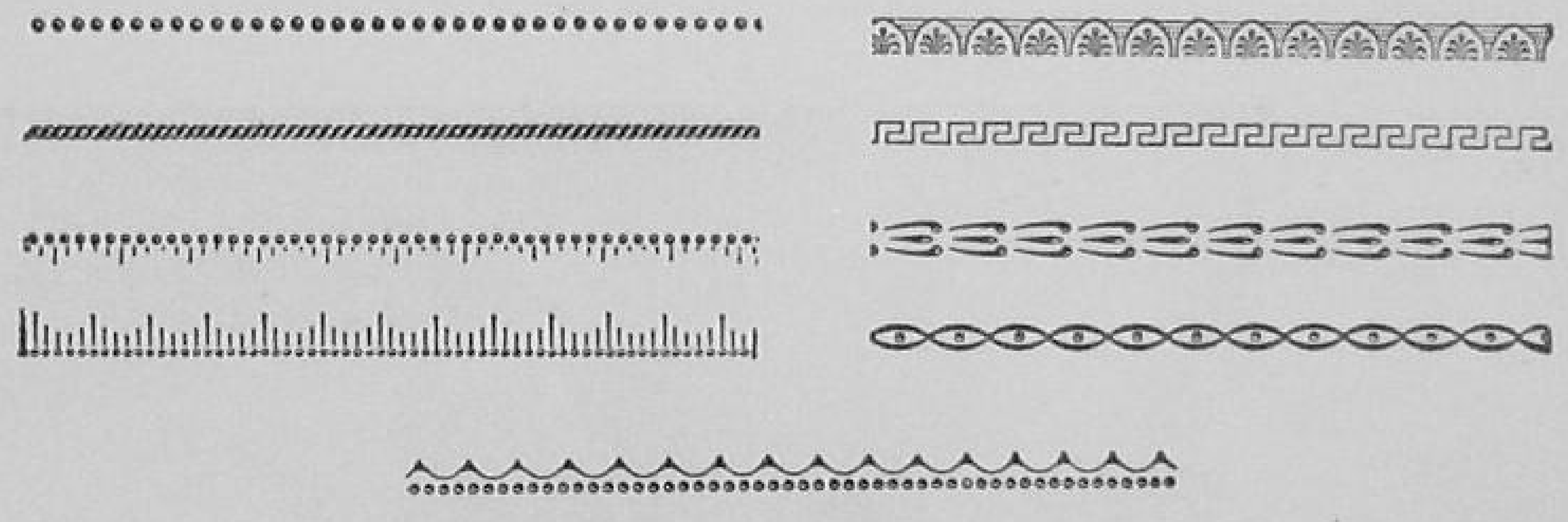


Fig. 76. Wheels.

(see Fig. 76). The carriage is equipped with a thumb screw so that the embossing wheels may be interchanged.

Dampen the leather project. Place a straight edge on the leather where the embossed border is to be made. Place the wheel alongside the straight edge. Apply considerable pressure upon the handle and push the wheel from corner to corner of the project (see Fig. 77). It is desirable to practice on a scrap piece before beginning work on the project.

68. Stamp or press the entire design on blotter corners with a linoleum block (optional).

A. Draw or trace design on a linoleum block.

B. Using the regular carving tools, carve the design into the linoleum. All parts of the design which are to be raised in the leather should be cut out of the block. This is just the reverse of linoleum block paper printing.

C. Dampen the leather and place the carved linoleum block on the grain side of the leather.

D. Hammer the block with a mallet. A more satisfactory method of

pressing the design into the leather is with a letter press. This method of stamping is very useful when duplicate pieces are to be made.

69. *Layout and punch lacing holes* (see Steps 21, 22, and 23, Chapter II).

The holes are not punched on the *inside edge* of the four pieces of lining leather.

70. *Lace blotter corners with the four-plaited round edge stitch* (review Step 27, Chapter II) sometimes called the Mexican Whip Stitch.

A. Begin the stitch by passing the lace through a hole, from back to front. Pull all the lace through and allow about one or two inches remaining in back.

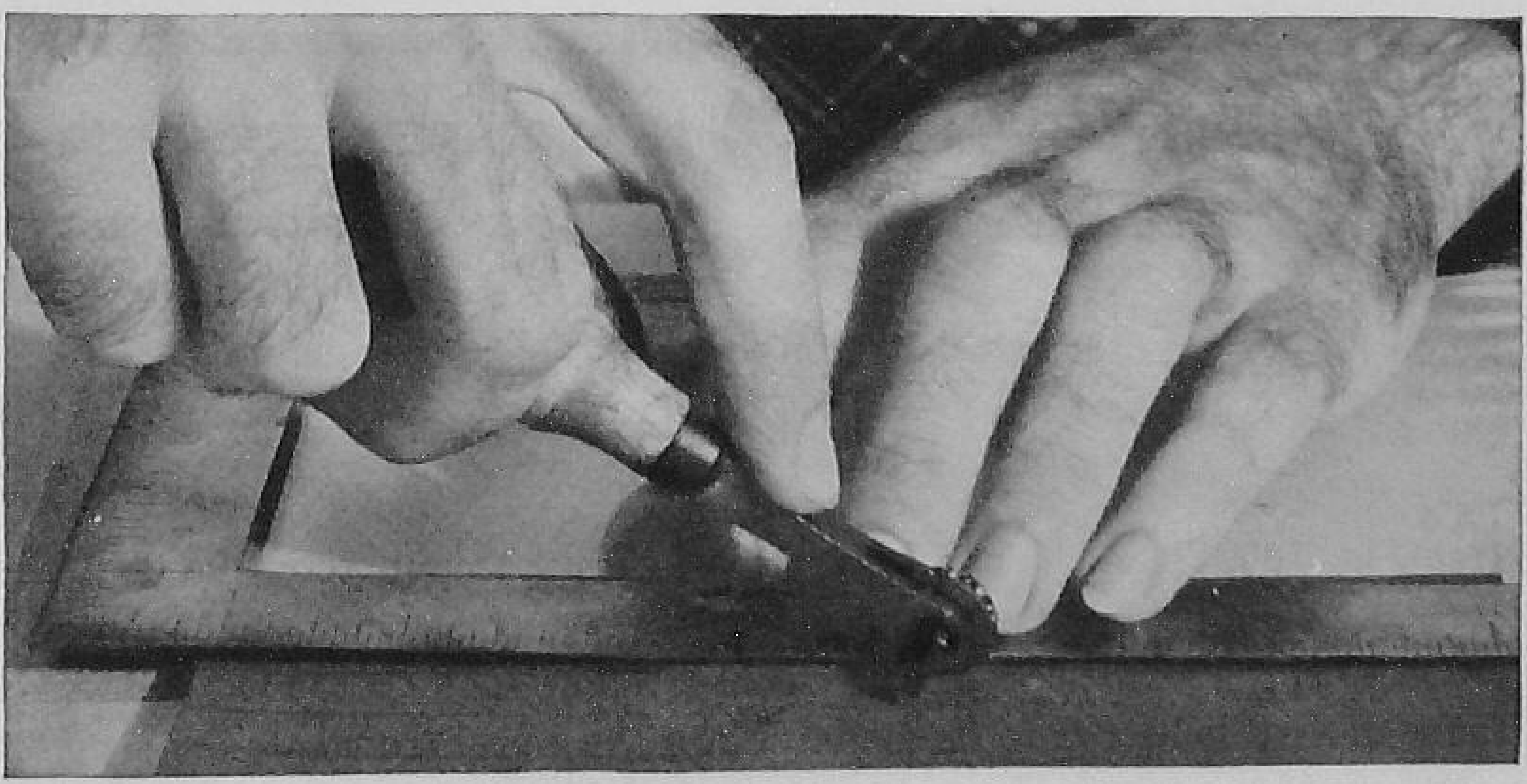


Fig. 77.

B. Count four holes to the right including the hole the lacing has been started in. Carry the lace to the right and over the top edge of the leather. Pass it through the fourth hole from back to front (see Fig. 78).

C. Carry the lace to the left and over the top edge of the leather. Pass it through the second hole from back to front as indicated by the white wire in Fig. 78. This step is shown completed in Fig. 79.

D. Again carry the lace to the right and over the top edge of the leather. Pass it through the fifth hole from back to front as indicated by the white wire in Fig. 79. This step is shown completed in Fig. 80.

E. Again carry the lace to the left and over the top edge, weaving it over one cross lace and under the other as indicated by the white wire in

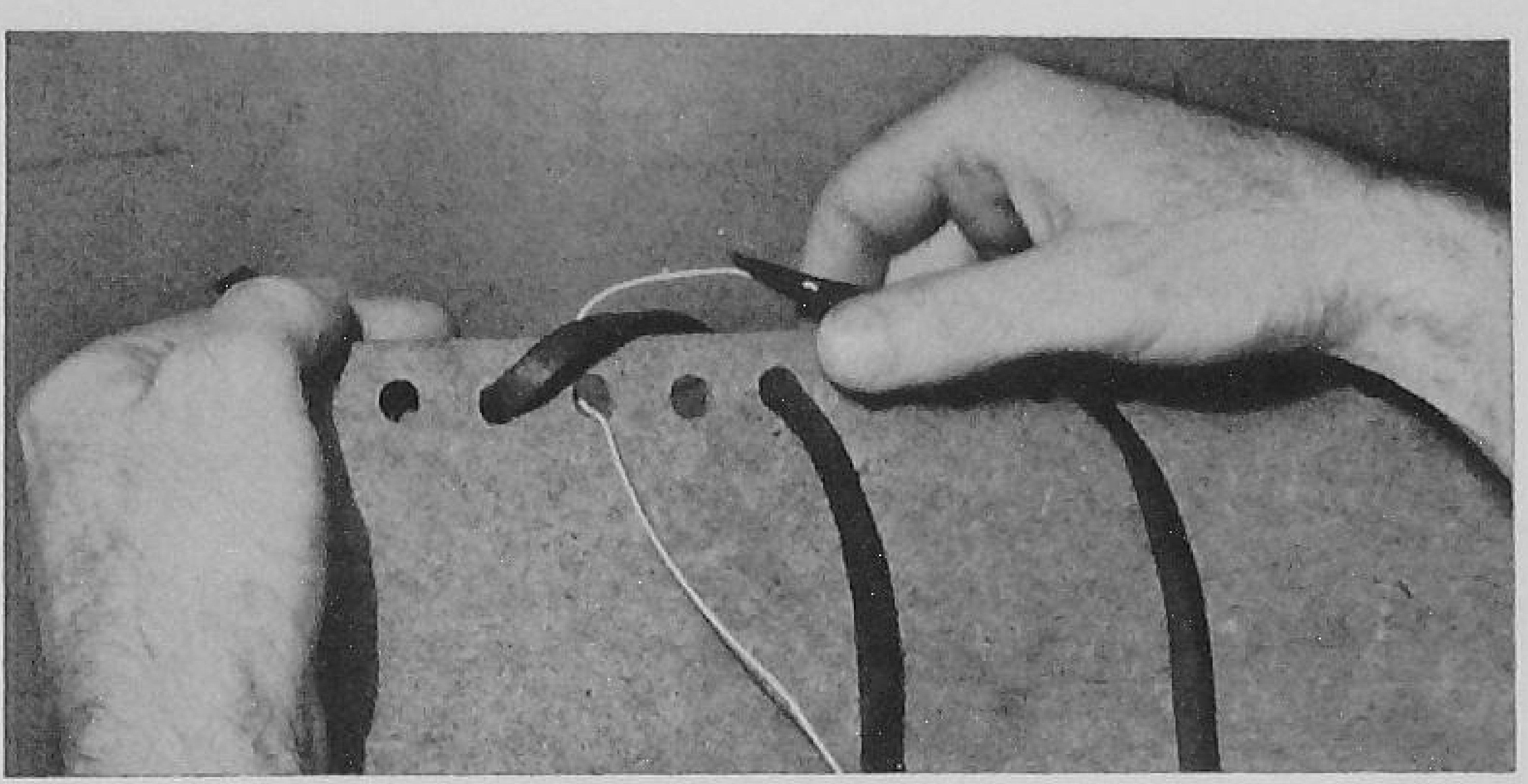


FIG. 78.

Fig. 80. Pass the lace through the third hole from back to front as also indicated by the white wire in Fig. 80. This step is shown completed in Fig. 81.

F. Carry the lace to the right and over the top edge, weaving it under one lace and over the other as indicated by the white wire shown in Fig. 81. Pass it through the next hole from back to front as also indicated by the white wire in Fig. 81. This step is shown completed in Fig. 82.

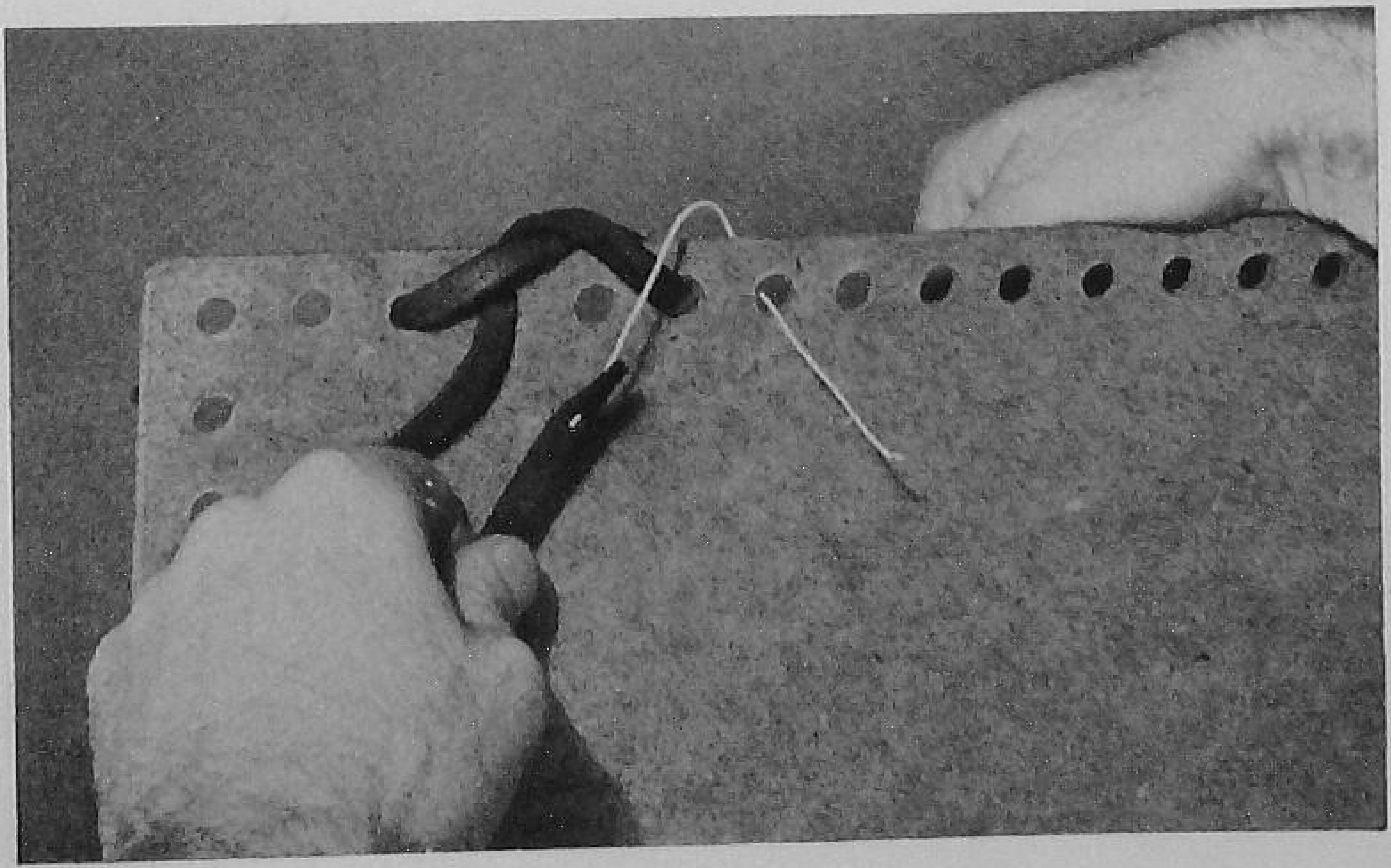


FIG. 79.

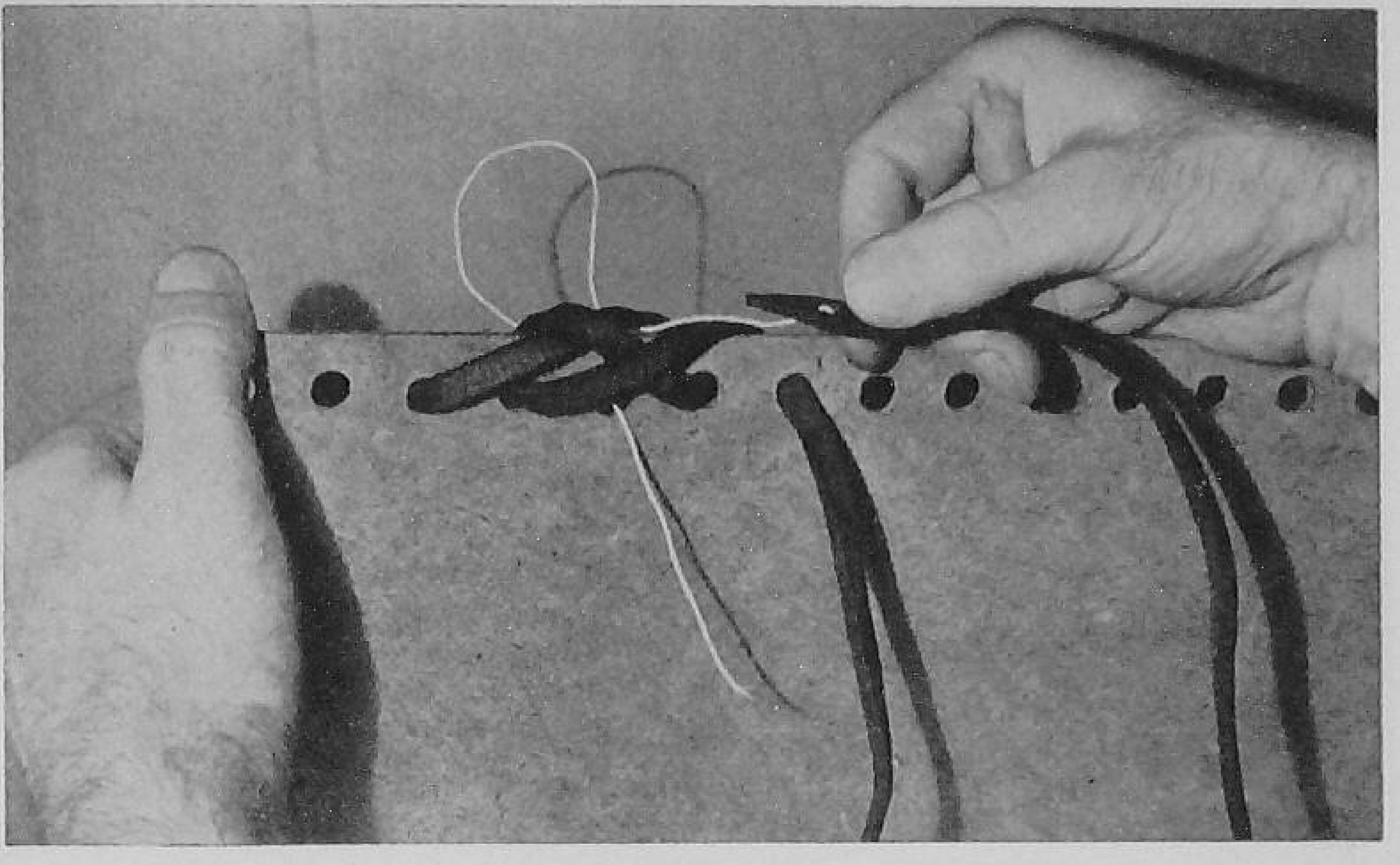


FIG. 80.

G. Again carry the lace to the left and over the top edge, weaving it over one lace and under another as before. Pass it through hole number four from back to front as indicated by the white wire shown in Fig. 82. This step is shown completed in Fig. 83. It wil' be noticed that there are two

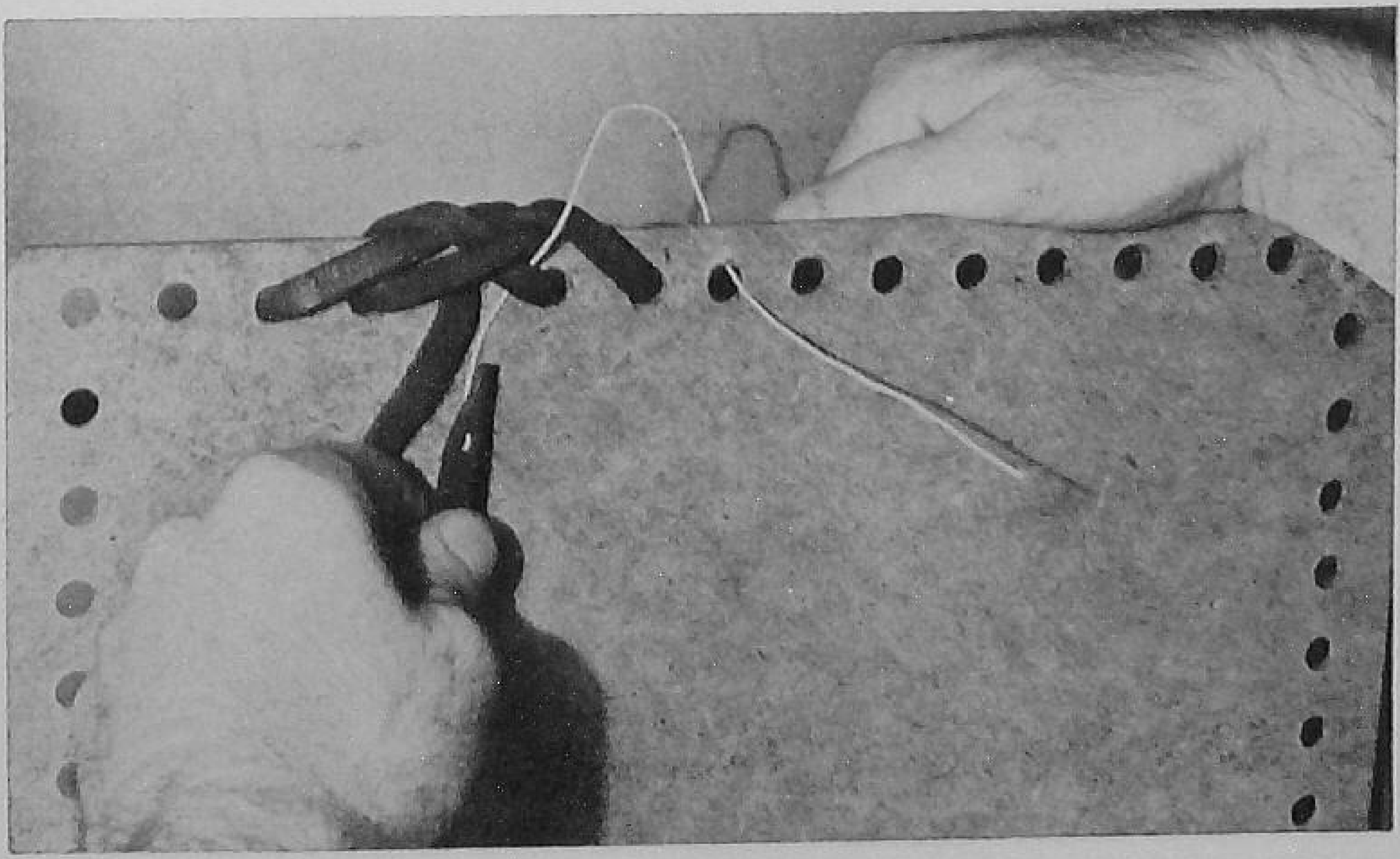


FIG. 81.

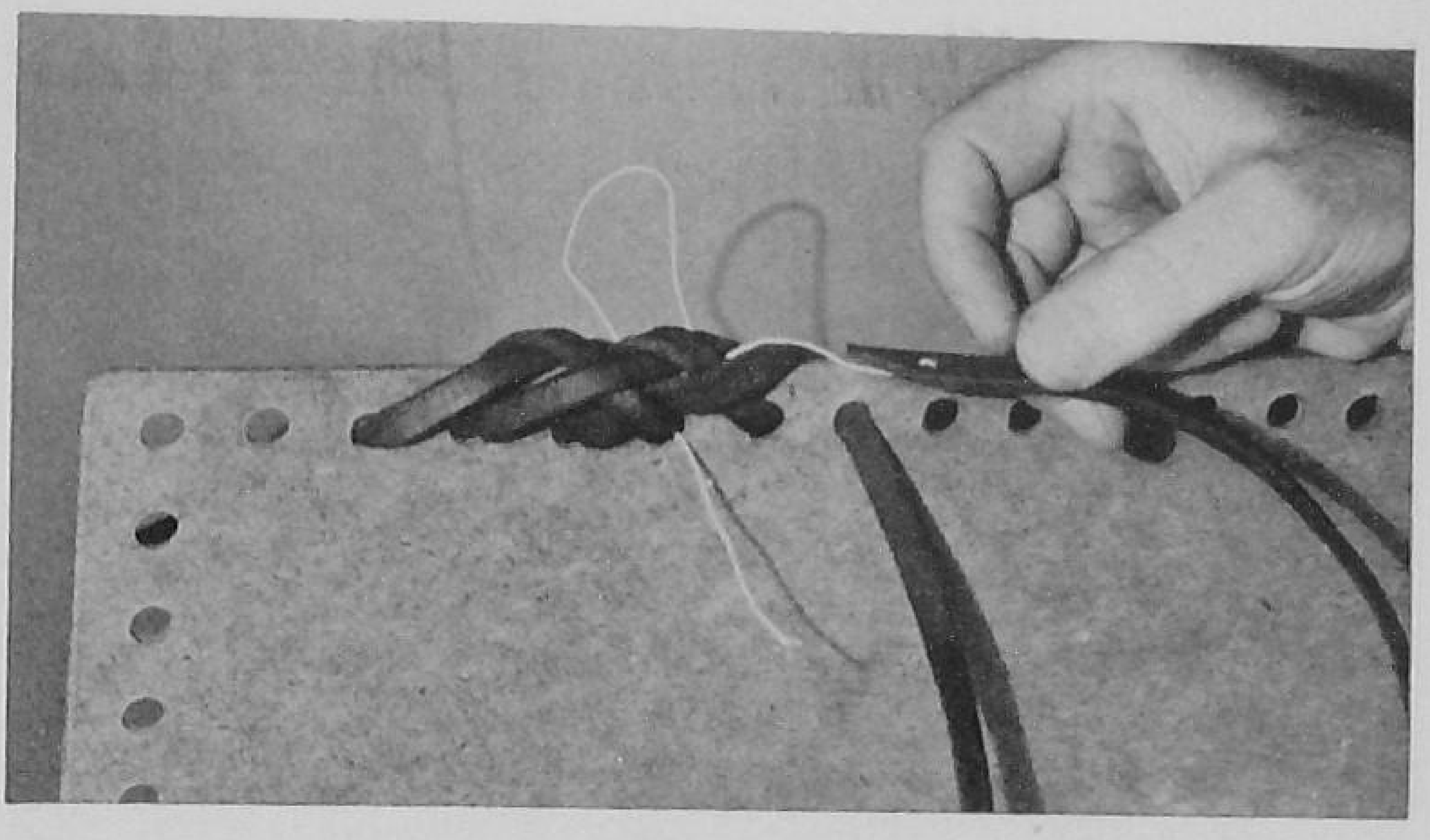


FIG. 82.

thicknesses of lace in hole number four. As this will be the case from this point on, an awl should be used to slightly enlarge the hole to accommodate the lace.

H. The white wire in Fig. 83 indicates that the lace is to be carried to the right under one lace and over another, the top edge of the leather and

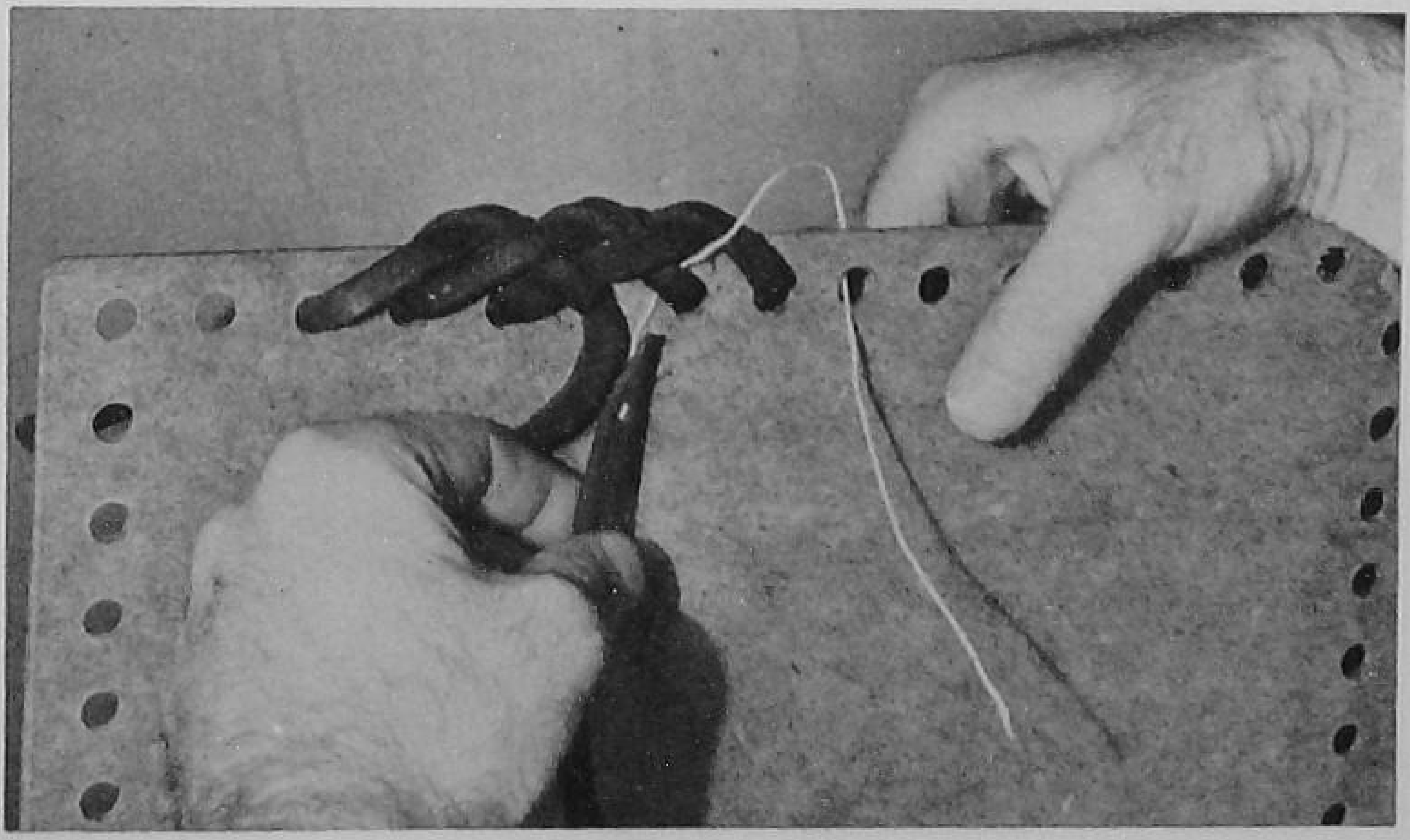


FIG. 83.

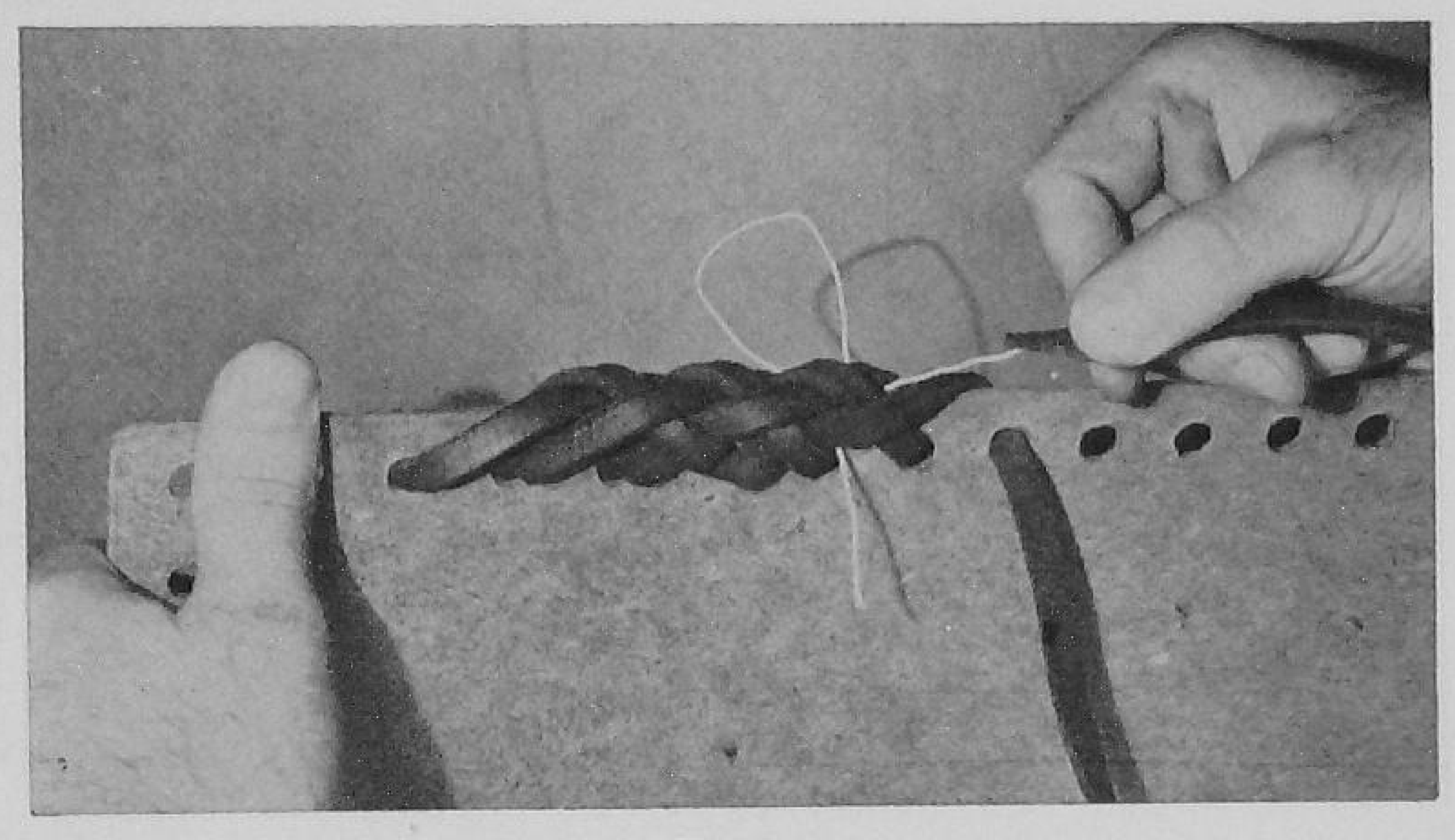


Fig. 84.

through the next hole from back to front. This step is shown completed in Fig. 84.

I. The white wire in Fig. 84 indicated that the lace is to be carried to the left, over one lace and under another, across the top edges of the leather and through hole number five from back to front. This step is shown completed in Fig. 84A, and the white wire in Fig. 84A indicates that the lace is to be woven under one cross lace, over another, across the top, and

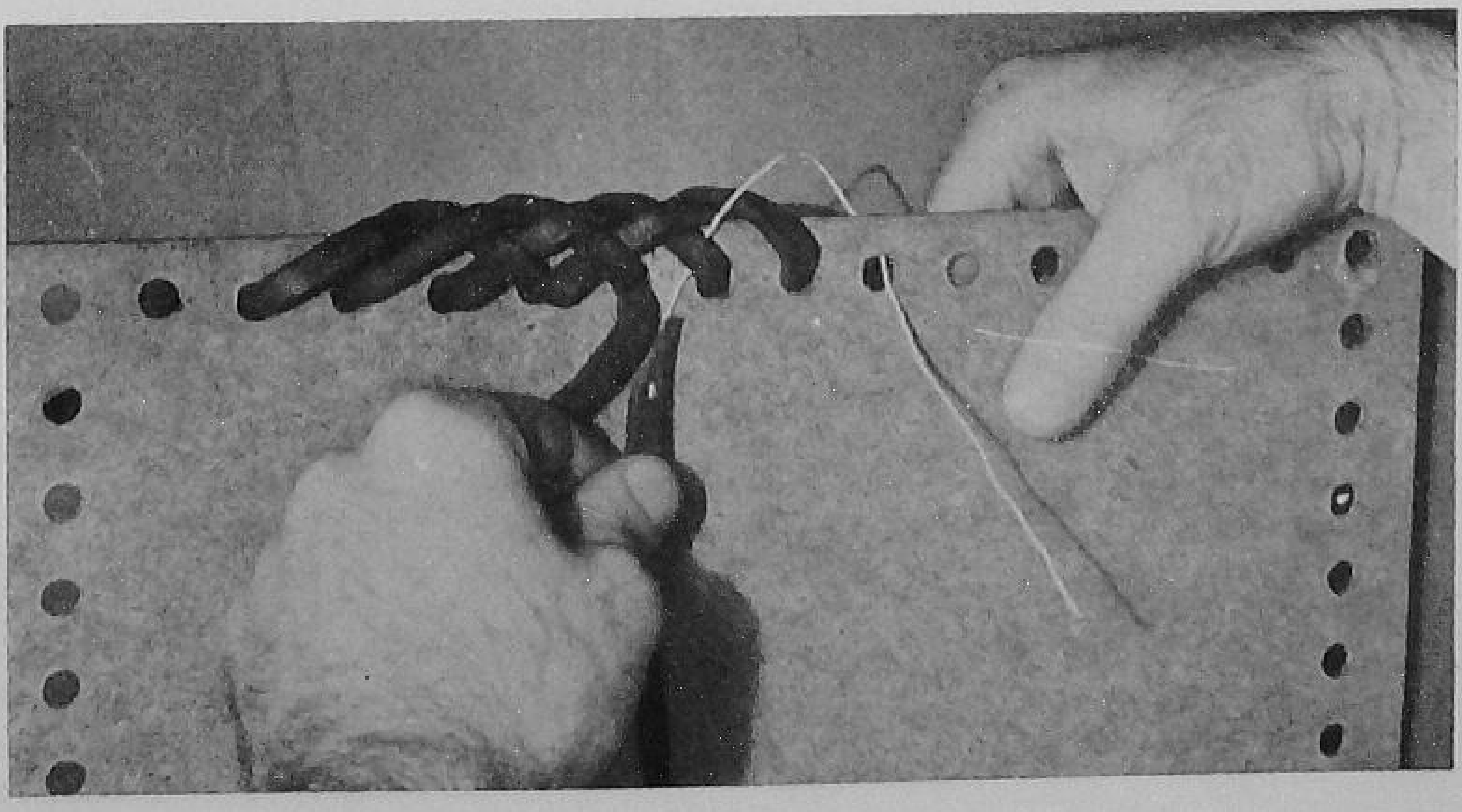


Fig. 84A.

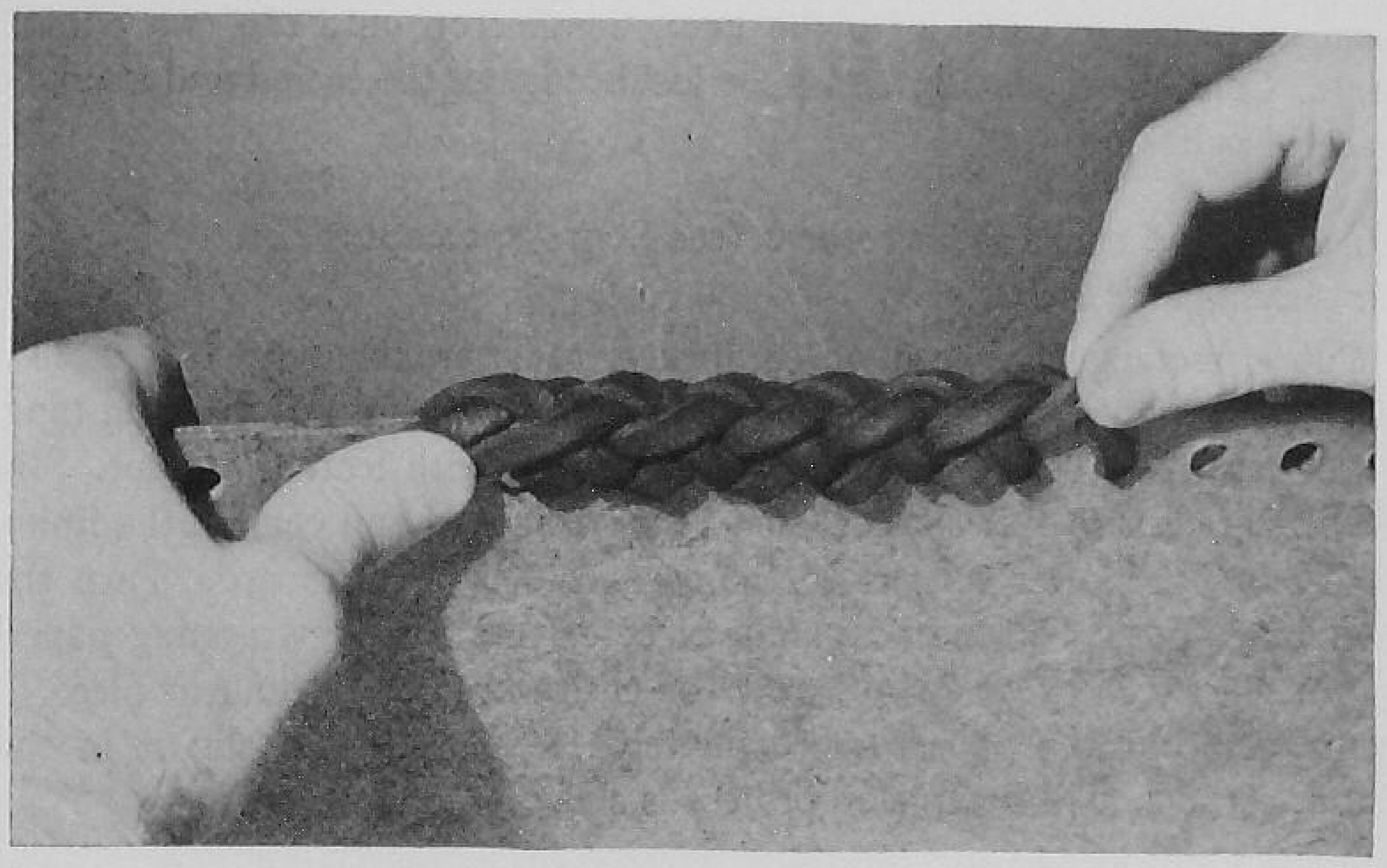


Fig. 85.

through the next hole. A section of this type lacing is shown completed in Fig. 85.

J. Continue the stitch around the blotter corner, lacing the tooled and

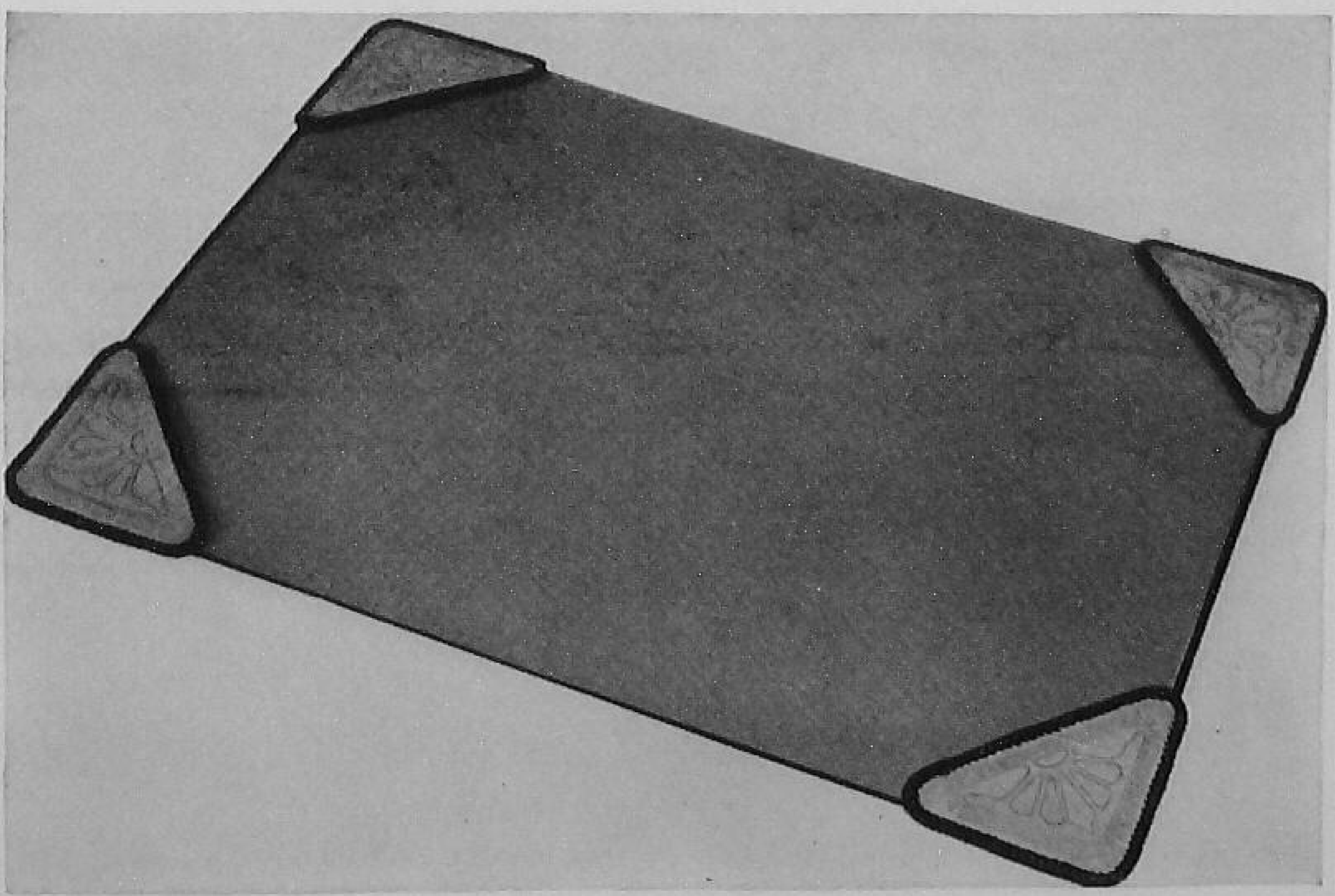


Fig. 86.

stamped pieces of calfskin to the lining leather on only the two outside edges. Continue the lacing across the inside edge of the tooled and stamped piece of calfskin.

71. Clean and wax blotter corners (see Step 27, Chapter II).

72. Assemble desk blotter.

Cut a rectangular piece of cardboard to approximately 18″ x 24″. Lightly sandpaper the edges and cover them with a length of masking tape.

Cover the inside surfaces of the lining leather with leather cement. Slip the blotter corners over the corners of the cardboard and cement the lining leather of the blotter corners to the corners of the cardboard. Turn the assemblage upside down and glue a piece of rectangular wrapping paper, approximately 17½″ x 23½″, over the entire bottom. Obtain a piece of rectangular blotting paper, approximately 18″ x 24″, and slip it in the blotter corners. The completed project is shown in Fig. 86.

Chapter VI

HOW TO MAKE PURSES AND HANDBAGS

The making of purses and handbags should not be attempted as a "first project" in leather work. If the beginning leathercraftsman desires to make a handbag as a "first project," it is highly recommended that he read the preceding chapters with care. It would also be advisable to read this entire chapter before beginning work. These projects require large amounts of tooling and lining leathers in addition to considerable quantities of lacing materials.

73. Select and trace a suitable design (see Steps 1 and 2, Chapter I).

The bag may be tooled or otherwise embellished on the front, front flap, back, handles, and gussets.

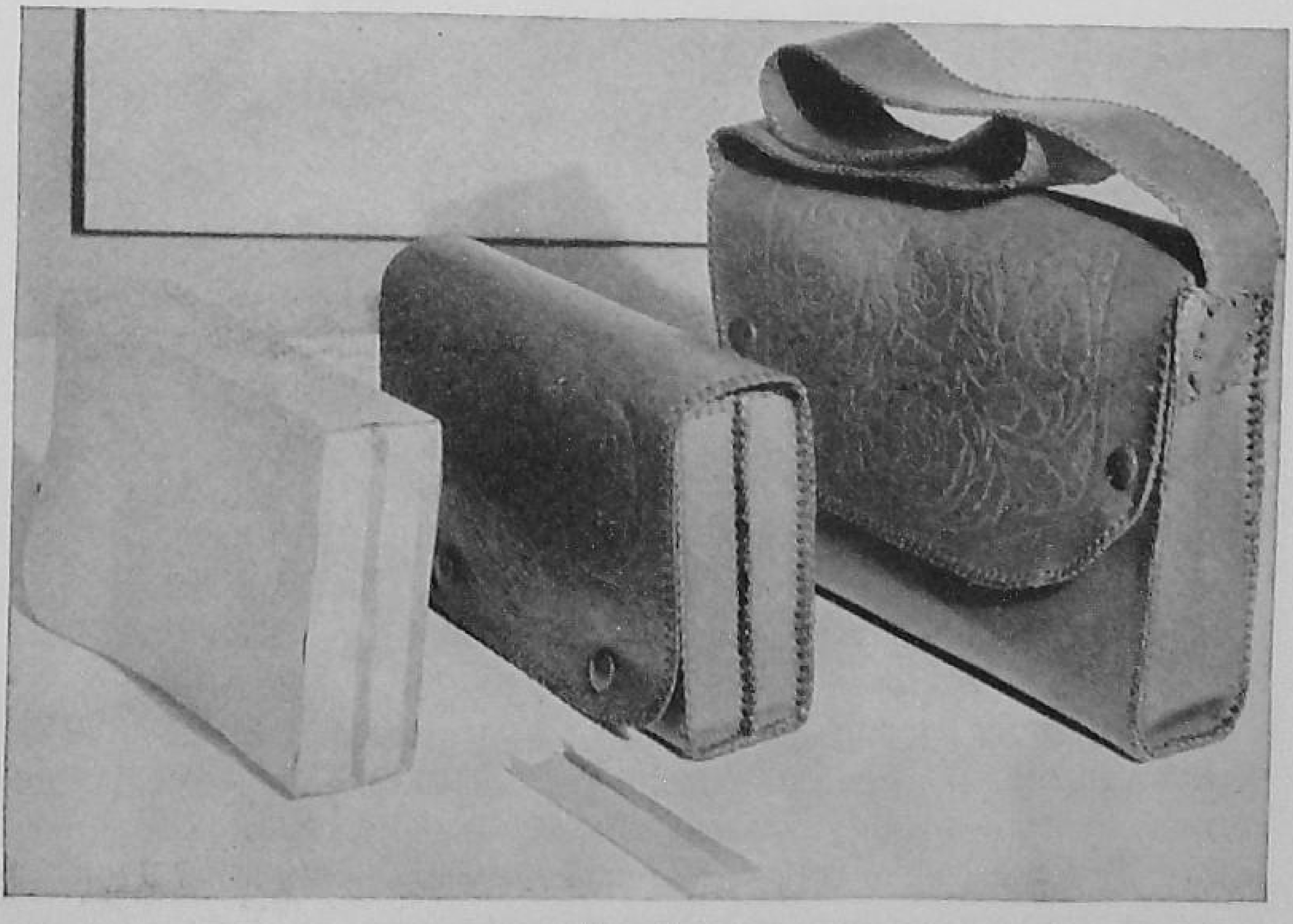


Fig. 87.

74. *Cut leather to desired dimensions* (see Step 3, Chapter I, and Step 16, Chapter II).

Bag shapes and sizes may be reproduced from various commercial articles or they may be designed by the craftsman. In either case, the patterns should be laid out on wrapping paper or oak tag and cut out with a pair of shears. The patterns should be assembled and lightly pasted or held

FIG. 88.

together with paper clips or Scotch tape. When the accuracy of the various pieces has thus been determined, cut the leather to size. Care should be taken to make sufficient allowance for lacing on all edges which are to be laced. (See assembled paper and oak tag bag patterns in Fig. 87 and 88.)

75. *Lay out and cut leather "gussets" for bag.*

Gussets are pieces of leather which give width and allow for expansion in size. They are used in the manufacture of such projects as bags, brief cases, cigarette cases, purses, card cases, etc.

The pattern for a straight gusset with cut-out corners and bent up edges is shown in Fig. 87. The gusset is cut from calfskin and the two bottom corners are notched out ¼" square. The edges are folded over and tapped lightly with a mallet to make a permanent crease or fold. This type of gusset is also very popular for leather cigarette cases. A V-shaped gusset is shown in Fig. 89.

Another very popular type is the continuous gusset. The length of this gusset should equal the distance around the two ends and the bottom of the bag. An allowance of approximately $\frac{1}{4}''$ on each end should be made to prevent "drawing in" at the corner. Cut a length of calfskin and fold lengthwise, grain side to grain side, as shown at *A*, Fig. 90. Hammer the

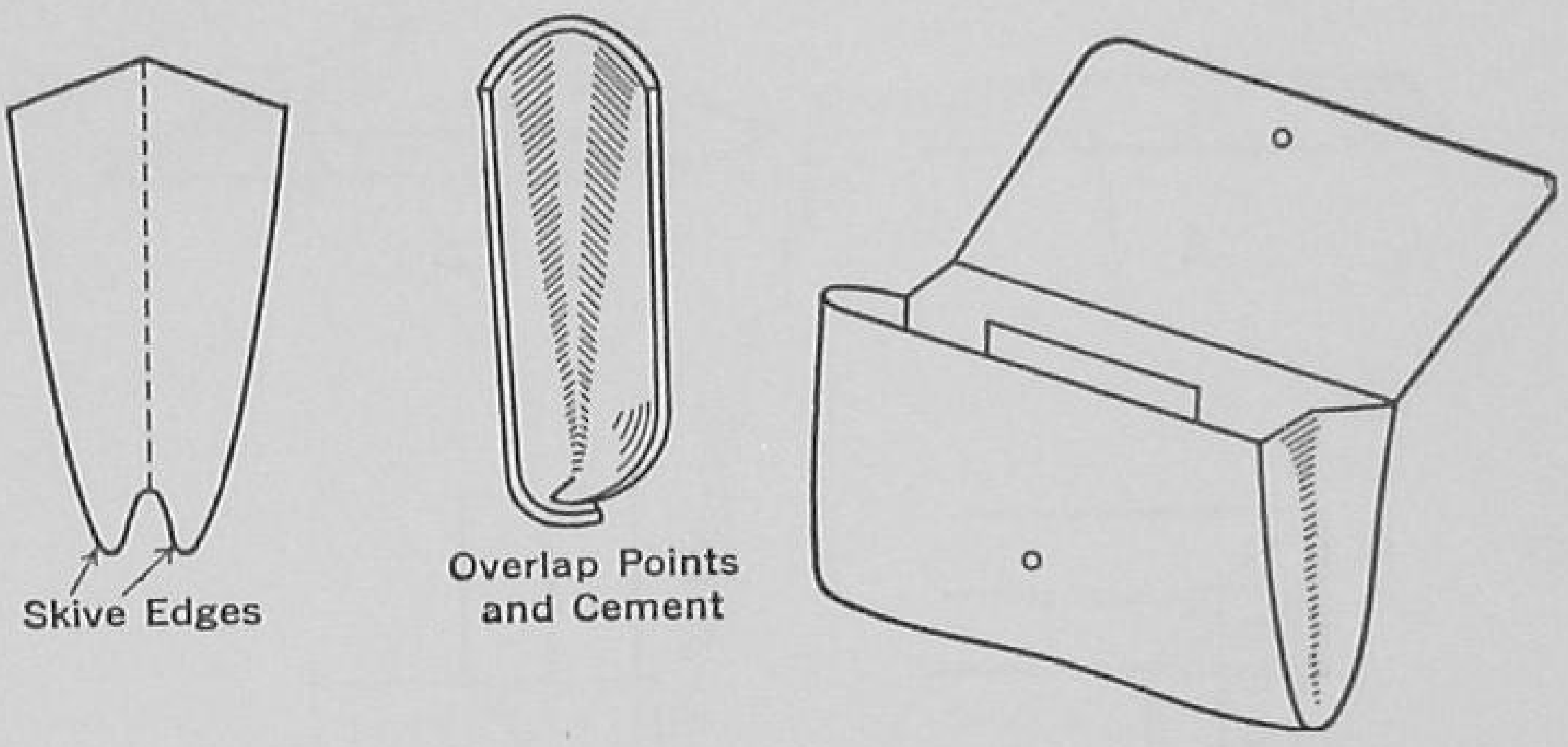


Fig. 89.

fold. Lay the gusset grain side downward. Mark off from each end a distance equal to the length of the side of the bag. Fold the ends of the gusset back on itself as shown at *B*, Fig. 90. Hammer the folds. Twist one end, which represents the sidegusset, at a right angle to the part of the gusset which represents the bottom, as shown at *C*, Fig. 90. Starting at the point of the diagonal fold, hammer only *HALFWAY* across the fold. Open up the diagonal fold and twist at a right angle in the other direction as shown at *D*, Fig. 90. Again starting at the point of the diagonal fold, hammer *HALFWAY* across the fold. Repeat the process with the other end of the gusset. The completed gusset is shown at *E*, Fig. 90, and its application at *F*, Fig. 90.

One continuous strip of leather can form both gussets and handle for the bag shown in Fig. 88. The joining is made at the center bottom of the gusset. Fig. 91 shows a coinpurse which is cut in one piece. The included gussets are shown by dash lines.

When attaching gussets, punching and lacing is rendered far easier if the edge of the gusset is first cemented and set into position.

76. *Decorate the bag in some manner as previously described in the foregoing chapters.*

77. Decorate bag with "Cloutage" (optional).

"Cloutage" is the decoration of leather by the use of fancy nail heads. There are two types of these nails. One has a straight shank, similar to a regular nail, and is used on leather covered boxes and other solid articles. The other type of nail has a split shank with two or four prongs, similar to

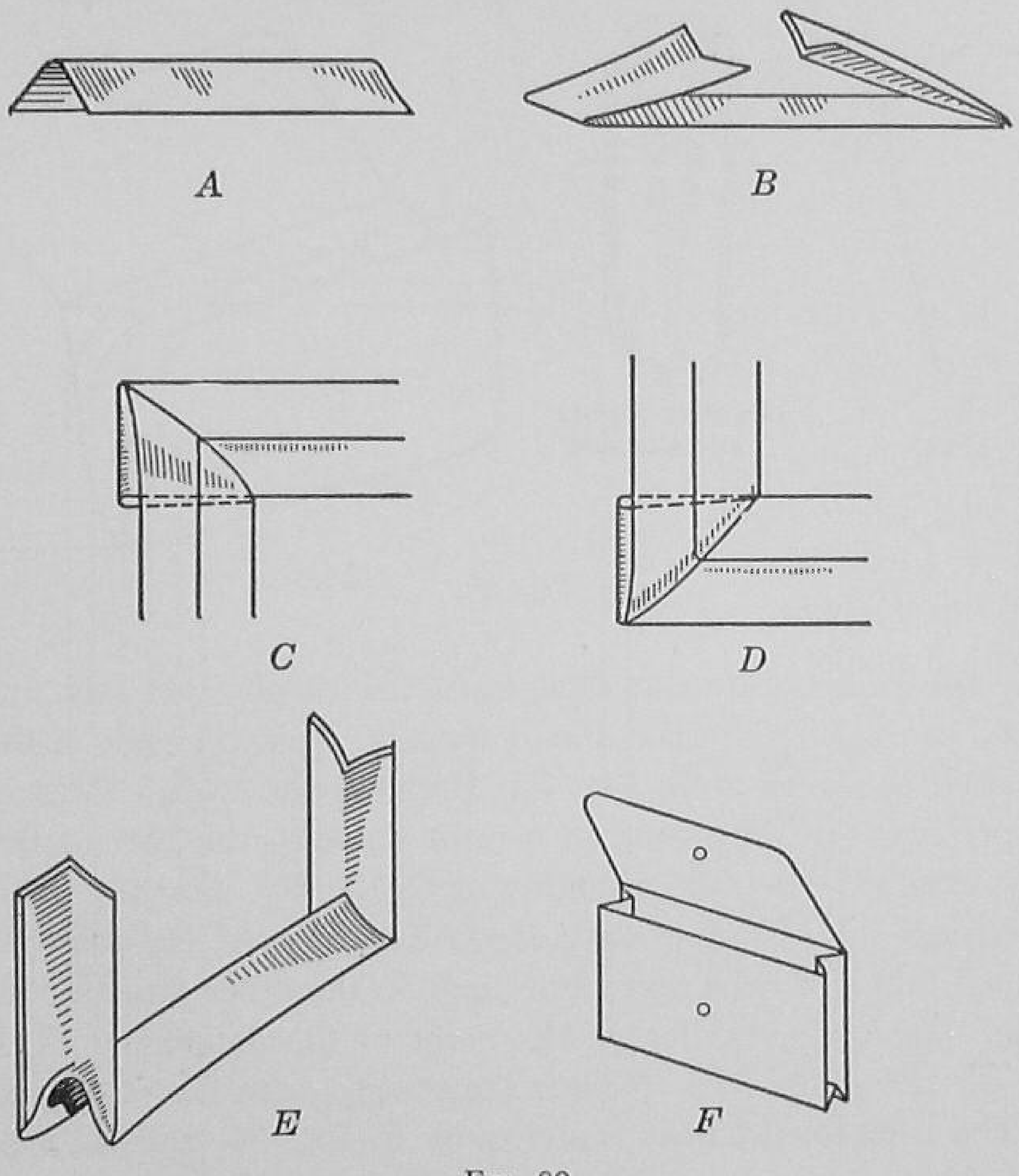


FIG. 90.

a split rivet or paper fastener, and may be used on all soft articles, such as bags, wallets, keycases, and the like.

Place the design sheet over the leather and locate the position of the nails by pricking through the sheet into the leather with a sharp pointed awl.

Pierce or punch holes through the leather and insert a split shanked nail through the hole with the bottom of the head flush against the tooled surface of the project.

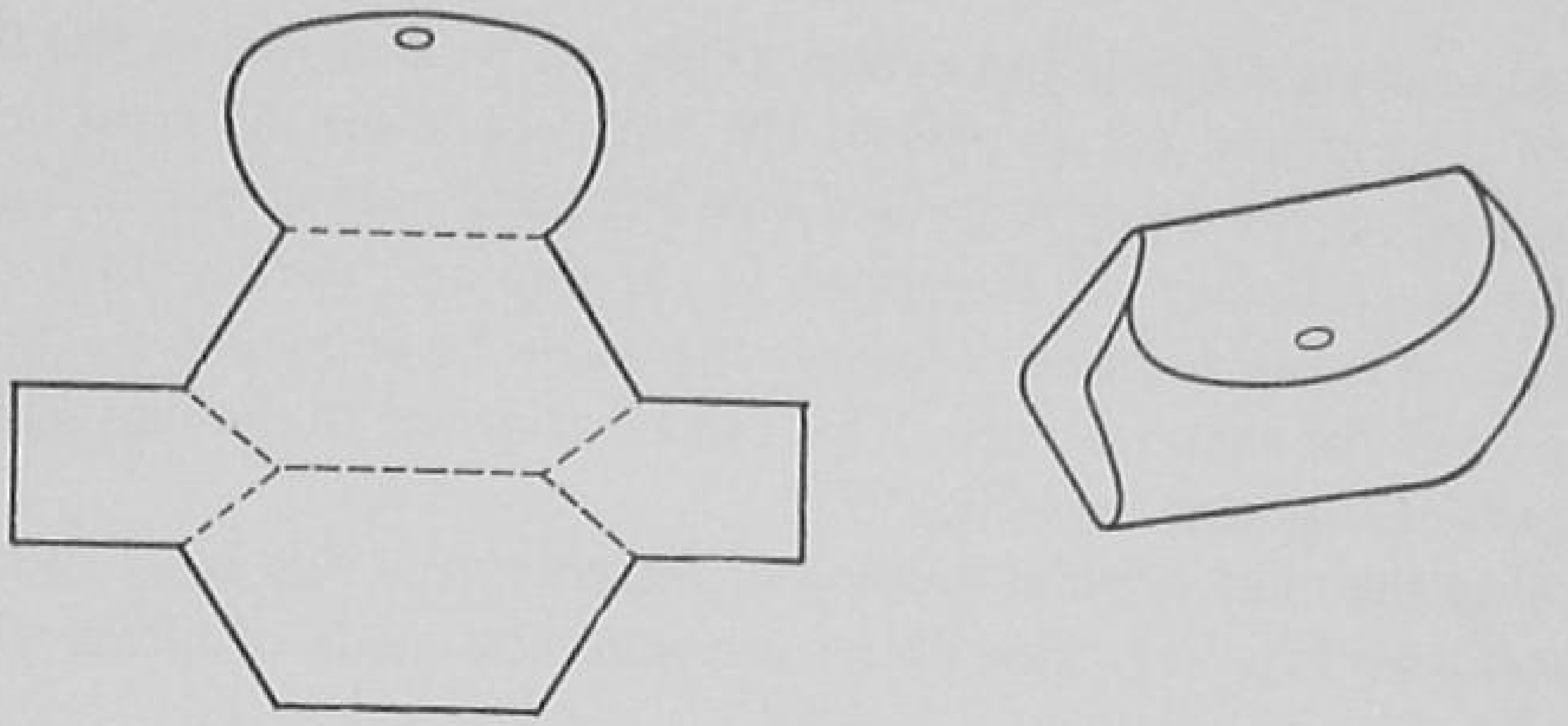


Fig. 91.

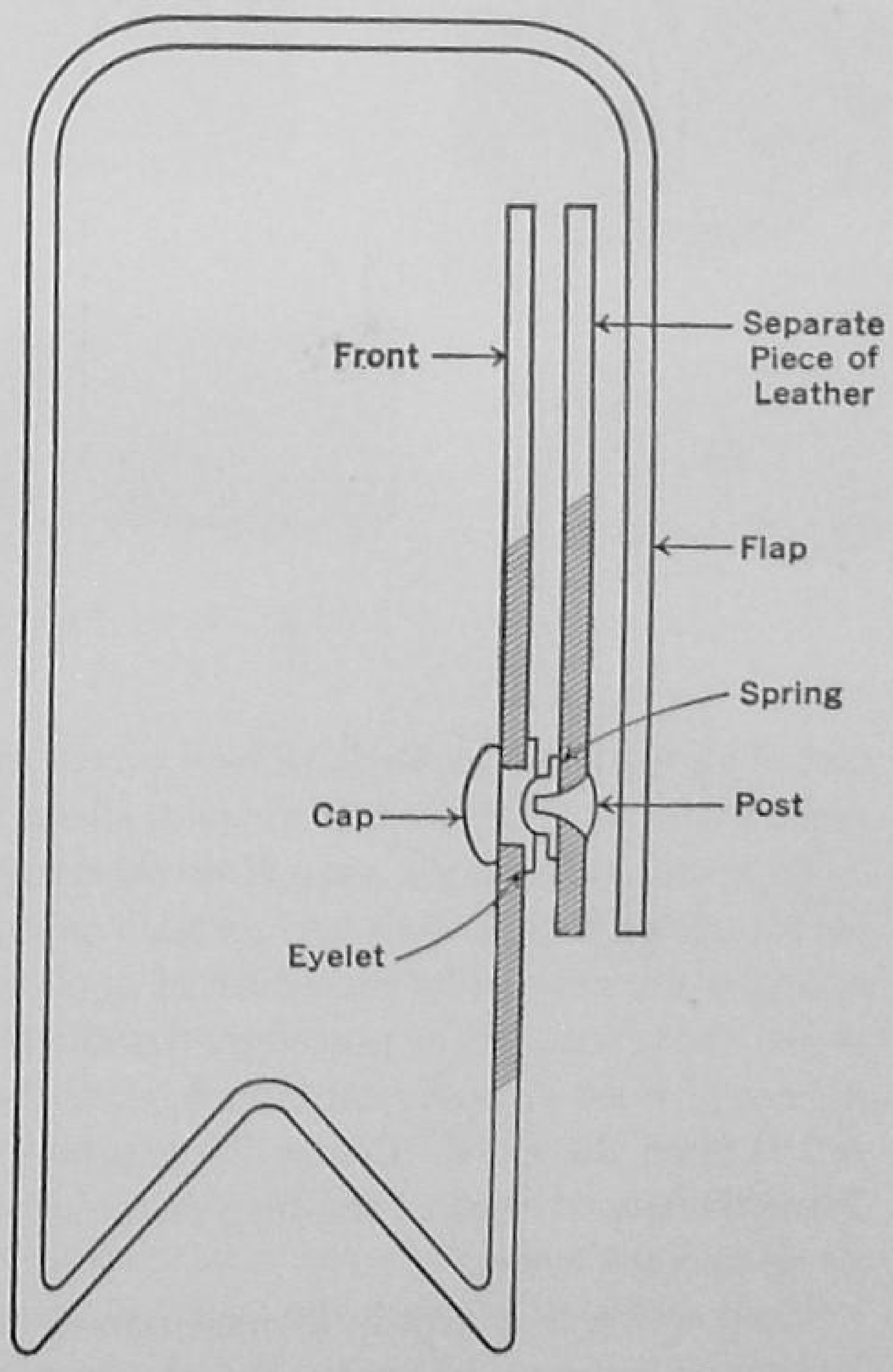


Fig. 92.

Bend down the split shanks in opposite directions on the flesh side of the leather. Lay the leather with the nail heads downward on a piece of soft wood and tap the bent-over prongs with a mallet.

The leather which contains the nails should be lined with heavy brown paper or buckram before the lining skiver is cemented on. This will prevent the flattened nail ends from showing through or disfiguring the lining leather.

78. *Apply leather lining and bag plates* (review Steps 25 and 26, Chapter II, and Steps 41 and 42, Chapter III).

One method of fastening the flap of the bag is with snap buttons (see Fig. 87). It is possible to use snap buttons without the unsightliness of the cap on the flap. A separate piece of leather must be

employed to carry the cap and eyelet. This can be attached to the flap by means of cement and act as part of the lining or it can be sewn or laced into place before the lining is applied (see left hand part of bag in Fig. 88). Many leathercraftsmen set the spring in the flap and the cap in the front of the bag. A separate piece of leather can again be employed to carry the spring part of the snap fastener. This can be attached to the flap and serve as an additional pocket (see Fig. 92).

Probably the most popular method of fastening the flap is by the use of bag plates (see Fig. 93). Bag plates are generally made of metal with the

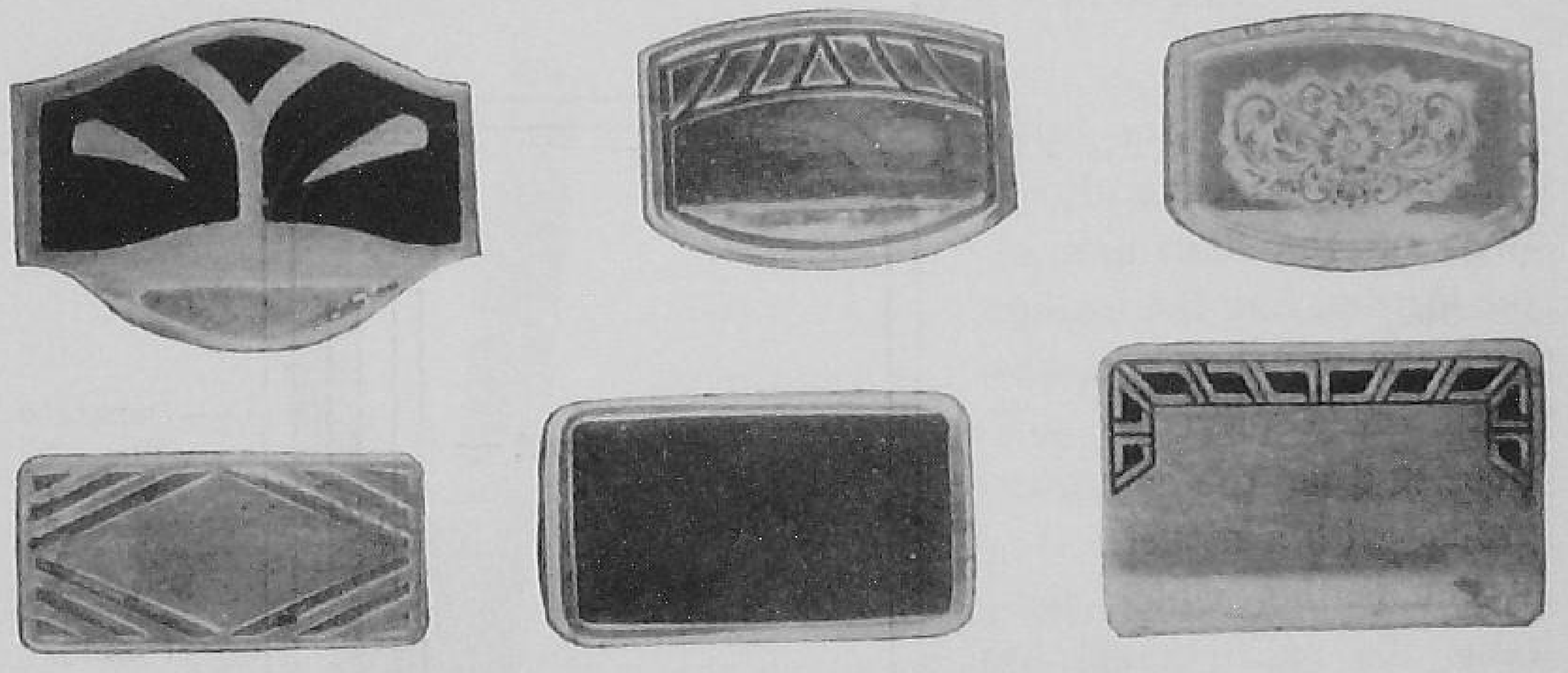


FIG. 93. Fancy bag plates.

post soldered onto the back. These plates are usually made of nickel but fancy plates may be obtained in gold, silver, or plastics.

To avoid cracking the enamel or otherwise marring the bag plate, support it upon a firm smooth surface such as wood or heavy cardboard before applying the cage. The procedure of applying the eyelet part of the snap is just the reverse of the procedure described in Step 26, Chapter II. Place a piece of wood or heavy cardboard inside the bag. Insert the hammer and rest it upon the wood. Center the cap over the half spherical depression. Place the largest anvil of the snap fastening set into the eyelet and hammer down into the eyelet.

Each spring is generally divided into six sections. If there is too much resistance between the spring and the button, slightly close two of the opposite sections with a pair of pliers. If the fastener is too loose, a tighter fit can be had if the top of the spring is struck several light blows with a mallet.

If the bag has been designed with pockets, these must be attached to the lining before cementing it to the bag.

Carefully locate the position of the back and front pockets. The top of each pocket should be approximately ¾″ below the top edge of the bag. Hand or machine sew them, on both ends and bottom, to the lining. Cement the lining in place.

79. *Lay out and punch lacing holes* (review Steps 21, 22, and 23, Chapter II, also Step 45, Chapter III).

Lay out holes on outside of bag. Assemble all parts and punch holes through all thicknesses of leather at one time. Be careful not to punch the holes too close to the edges. Some leathercraftsmen punch holes on the outside sections of the bag. Then, after the assembly has been cemented together, the holes are punched through the remaining layers of leather using the previously punched holes as a guide. This method requires less strength in using the punch. In some cases, particularly around sharply curved corners, it is desirable to punch the holes as the lacing progresses.

80. *Attach slide fastener to center of top gusset (optional).*

Slide fasteners (see Fig. 94) are made of interlocking teeth, which are mounted on woven tape. The teeth are usually made of nickel silver and the tapes are generally black, brown, or white. The white tapes may be stained to match the leather. Fasteners may be had in varying lengths of from 3″ to 22″ and longer. It is now possible to obtain slide fasteners with plastic teeth on corresponding colored twill tape.

Slide fasteners may be hand or machine sewed into a slot which has been cut into the leather (see Fig. 95). The slot should

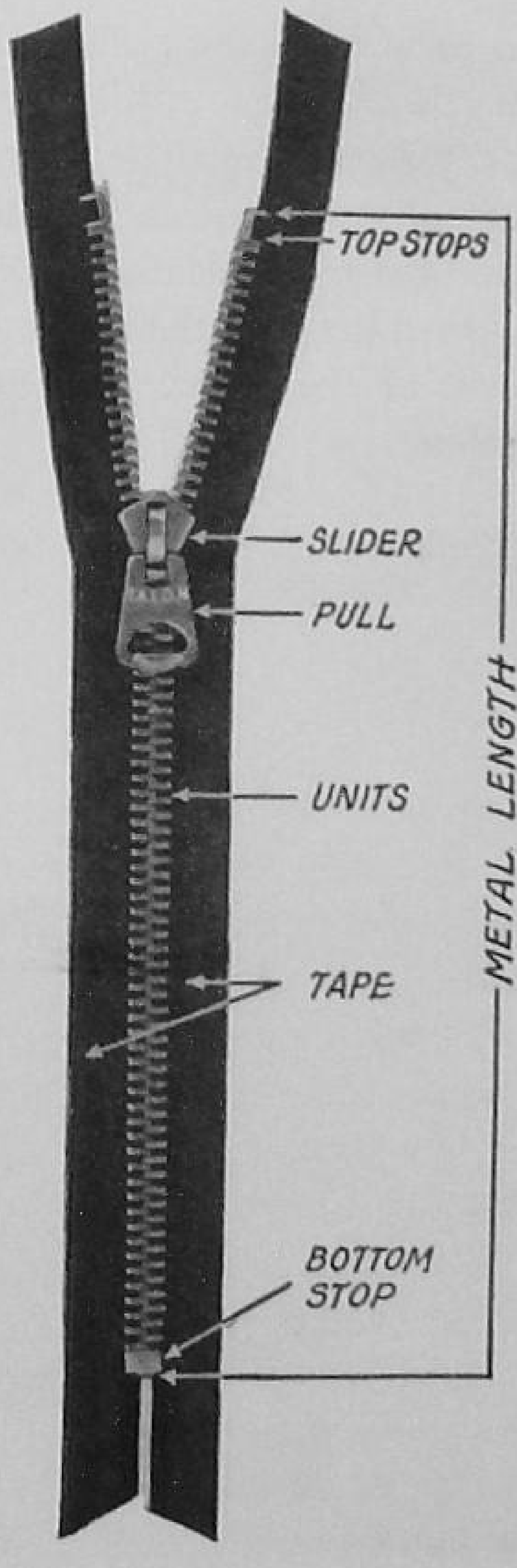


FIG. 94.

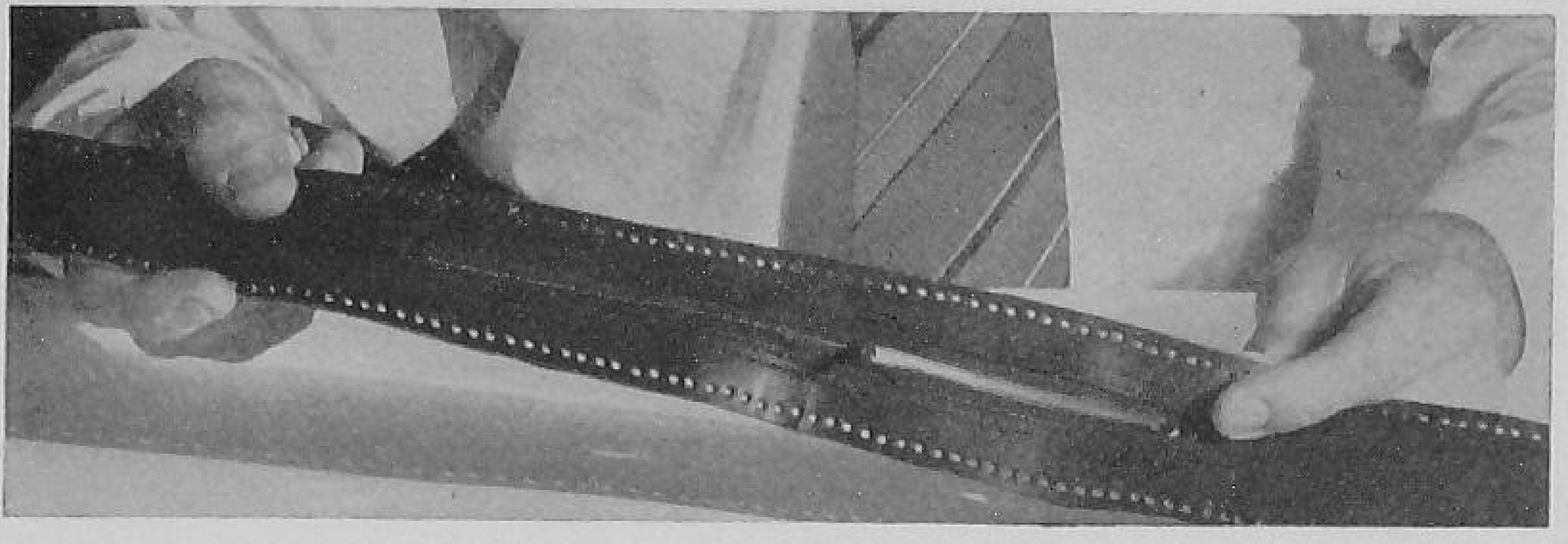


Fig. 95.

be as wide as the pull of the fastener and slightly longer than the metal length. Apply a small amount of leather cement to the tape and temporarily fasten the zipper into the slot. Care should be taken to prevent the cement from touching the teeth. Be sure the zipper is closed when sewing the tape to the leather and be sure that a clear space of at least 3/16″ is allowed between the metal and the edge of the leather to afford easy movement of the slider. Fig. 96 shows a zipper handbag being prepared for lacing.

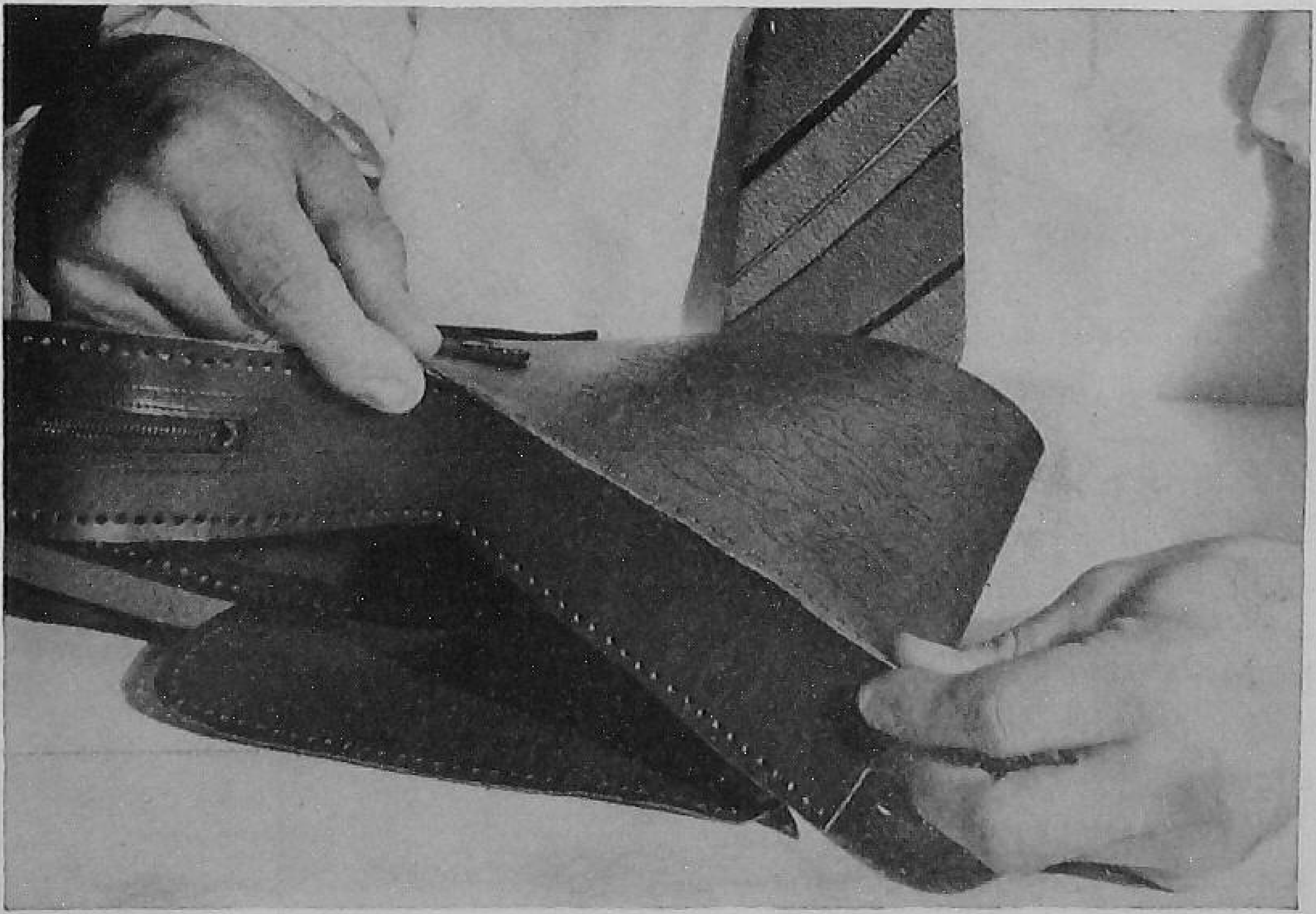


Fig. 96.

81. Attach handles to bag.

The handle is usually fitted last although sometimes it is necessary to attach it to the bag prior to lining. There are many different types and styles of handles.

The handle on the bag shown at the right in Fig. 87 is merely a piece of leather which has been lined, laced, and fastened to the gussets by knotting the lacing in punched holes.

The handle on the bag in Fig. 88 serves as both handle and gussets. It is lined, punched, and laced to the bag.

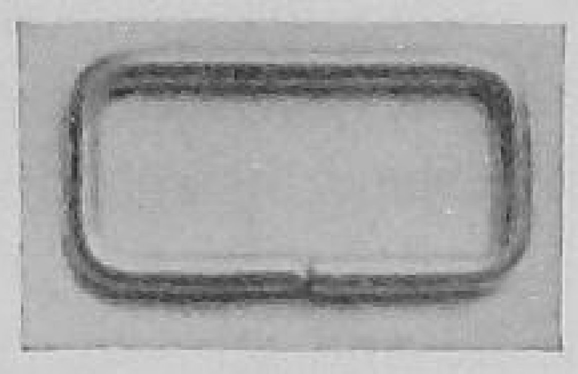
Fig. 97.

Fig. 97 shows handles which have been riveted to the bag. The type of rivet used is shown in Fig. 98. The two parts are driven together with a mallet. It will be noticed that both parts of the rivet have finished heads.

Metal loops and dees (see Fig. 98) are often used to attach handles to bags. The method of application is shown in A, Fig. 99.

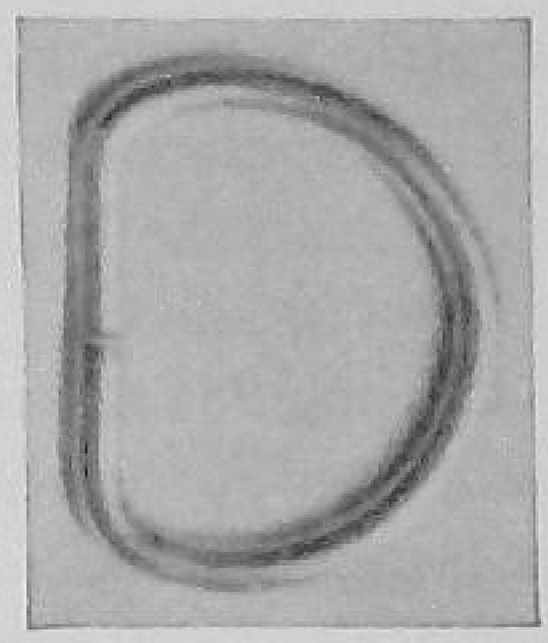
A leather tab is pulled through the ring, doubled back, and laced or

sewed to the gusset. The end of the handle is also pulled through the ring, doubled back, and laced. The method of attaching the tab or arrowhead to the



Loops—For handles, Sizes: ½″, ⅝″, ¾″, ⅞″, 1″, 1¼″.

Rivets. Will take any thickness of leather up to ¼″. Excellent for bag handles, belt loops.



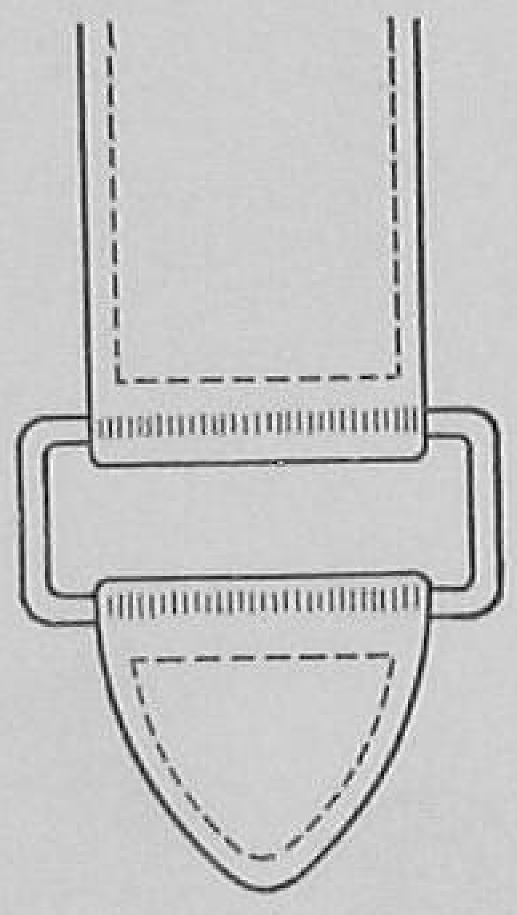
Dees—For handles, Sizes: ⅜″, ½″, ⅝″, ¾″, ⅞″, 1″, 1¼″.

Fig. 98.

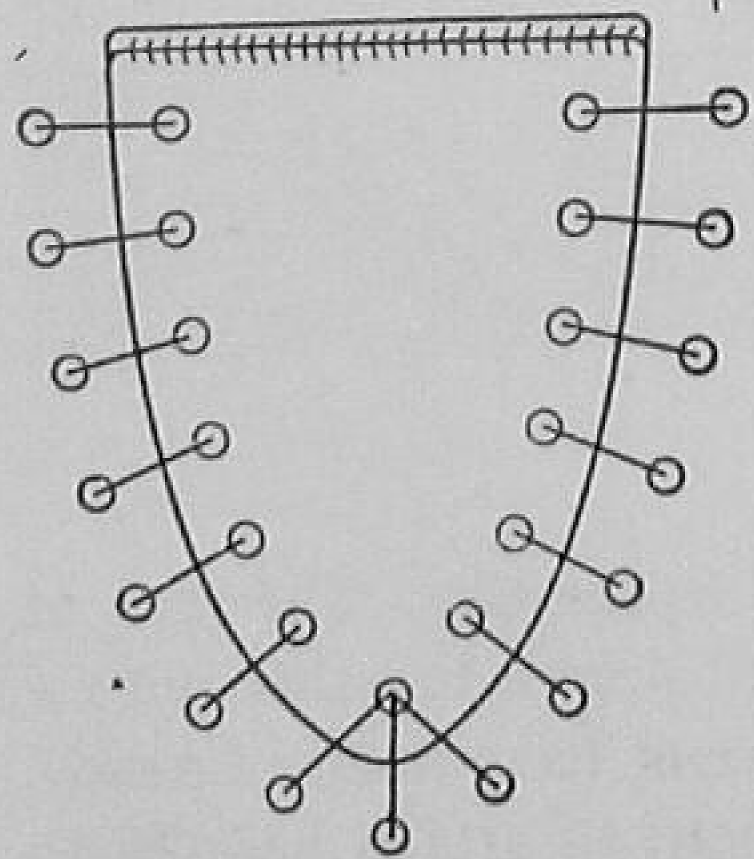
bag as shown in Fig. 99 may be modified by lacing it to the bag. Holes are punched along the cut edges of the tab. Superimpose the tab in position on the bag. Mark location of holes in the bag. Remove the tab and punch holes in the indicated position through the bag. A second row of holes must be punched into the bag which will be flush with the cut edge of the tab. These holes must be spaced around the edge of the tab to provide for uniform lacing. Three to five extra holes are usually punched at the tip of the tab. This provides a means of lacing around the point of the tab in a manner similar to that used on the corner of the keycase (see *B*, Fig. 99). The button-hole or double loop stitch may be used.

A laced handle may be inserted through the slotted side of the bag as shown at A, Fig. 100. The end may be secured to the side of the bag as indicated at B, Fig. 100, the ends of the lace being glued down inside the bag as shown at C, Fig. 100.

A handle may be fastened directly to the back of the bag when the bag is being laced (see A, Fig. 101). The two small cross straps are laced to the back of the bag and the ends



A



B

Fig. 99.

of the lacing are glued down inside the bag as indicated at C, Fig. 101. The handles may also be fastened with snap fasteners. They may then be removed when desired.

Many other methods of attaching handles to bags may suggest themselves to the leathercraftsman. The important thing to remember is that the design of the handle and its fastening should be in keeping with the design and purpose of the bag. It should be easy and comfortable to hold and should be strongly made and securely fastened.

82. *Lace the bag in some manner as previously described in the foregoing chapters. Clean and polish.*

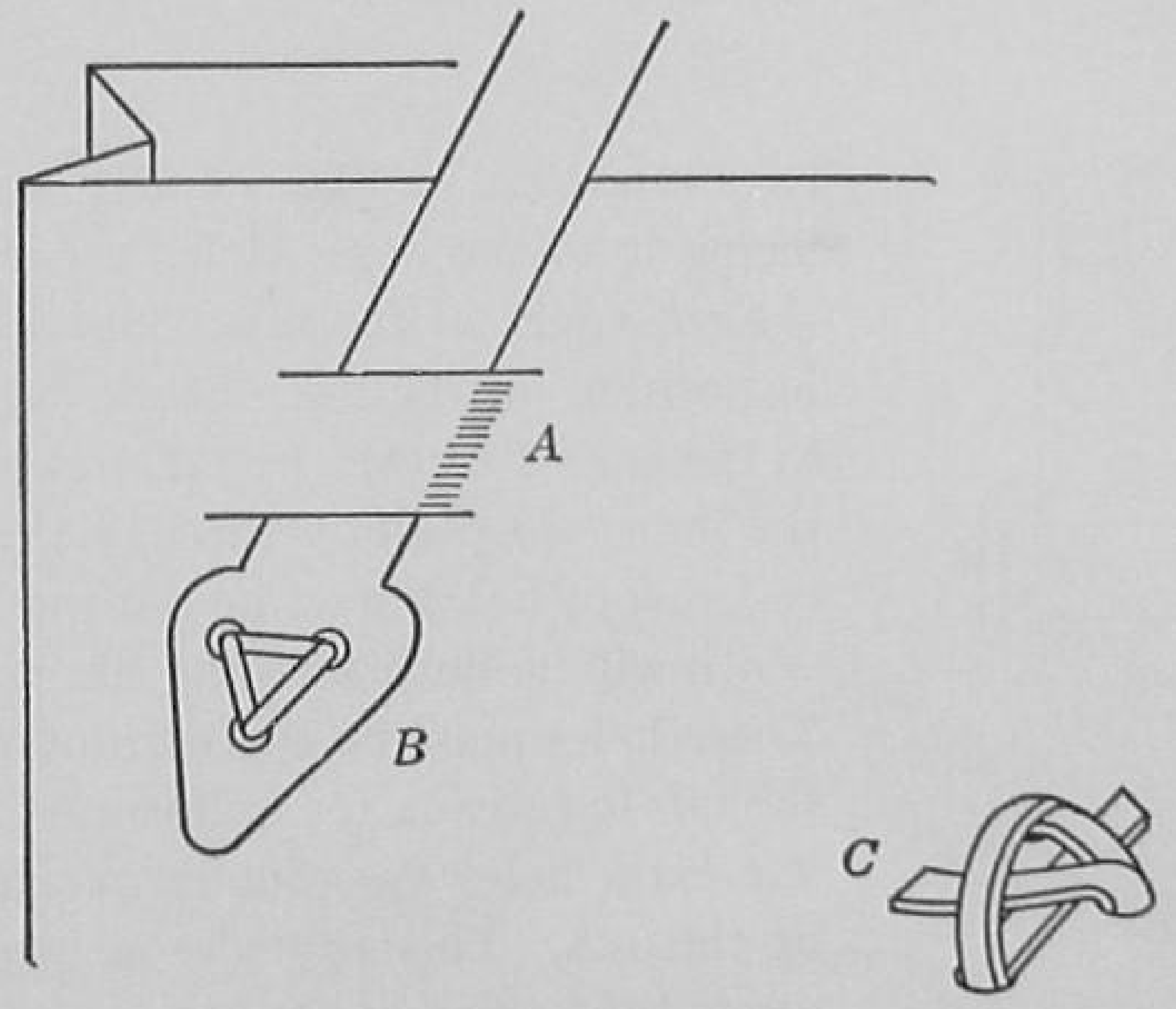


Fig. 100.

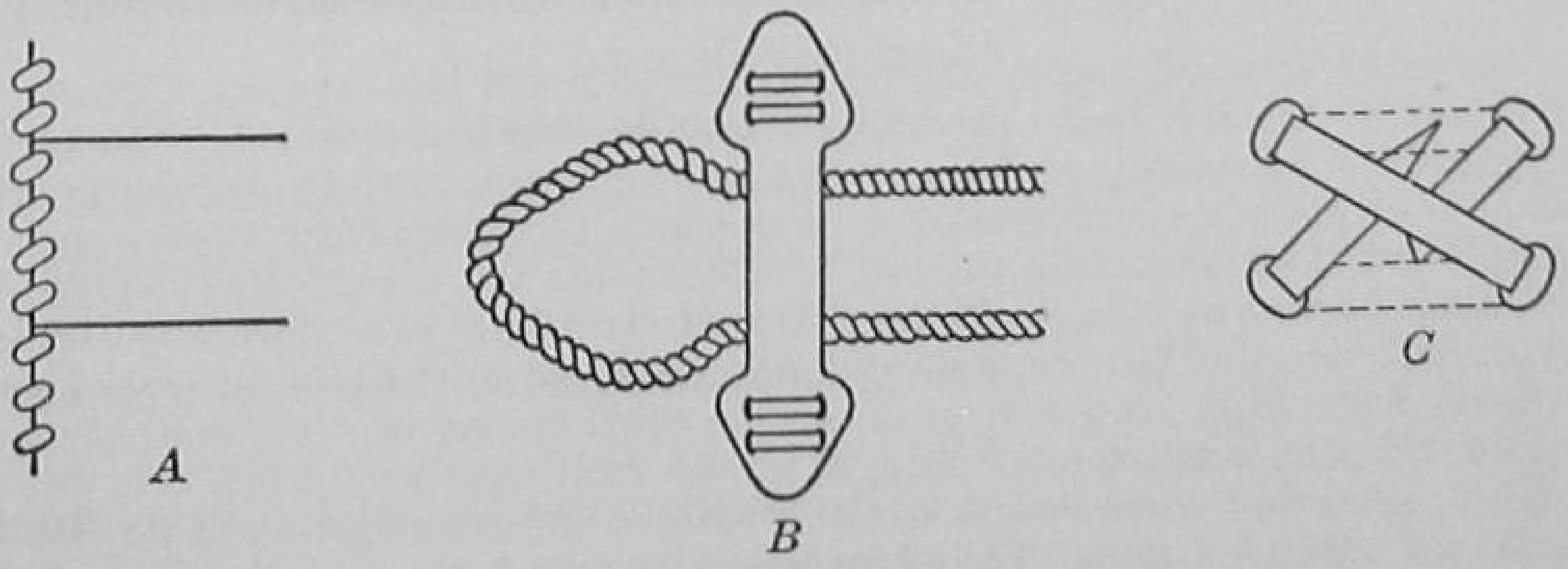


Fig. 101.

Chapter VII

HOW TO MAKE A CARVED LEATHER KNIFE SHEATH

Of the many forms of leather decorating, carving is the least known. This can be attributed to the fact that comparatively few craftsmen, mostly professional, who have had an opporunity to learn leather carving, have carefully safeguarded the methods of procedure and have kept them within their immediate circles, more or less a secret. Leather carving was first introduced into this country by the early day Spaniards by way of Mexico. Today it is used extensively in a professional manner by manufacturers of Western saddlery, belts, handbags, brief cases and other leather articles. Aside from being a form of art by which leather can be beautifully decorated, it has its practical qualities, such as: the great variety of design that may be applied, speed with which designs can be completed and the durability of the leathers which are used for carving. The waste basket illustrated was made from two thicknesses of carving cowhide glued back to back. It was laced with ⅝″ strips of tooling calfskin. The hand bag and book cover were made from light weight tooling cowhide. The book cover was laced with ⅜″ Florentine lace.

The meaning of the term "carving" is rather obscure. Some authors interpret the term to include such processes as modeling, stamping, incising, beveling, etc., while others limit the meaning to the specific process of undercutting and filing, to obtain relief in the design. The term "carving" as used in the following instructions will refer to the latter interpretation.

83. Select suitable leather.

Cowhide is generally used for incising and carving. Tooling cowhide (Alhambra) may be obtained in three different weights: light weight, 2½ oz.; heavy weight, 5 oz.; and extra heavy weight, 8-9 oz. The skins average between 22 to 26 square feet and may be obtained in the natural color only. This leather is excellent for all types of tooling and coloring. The light weight is used for purses, handbags, and book covers. It may be used for incising and carving. The heavy weight is suitable for belts, knife and ax sheaths, chair backs, fire screens, briefcases, etc. Carving Cowhide (8-9 oz.) is a heavy weight cowhide especially finished for incising, carving, and stamping. It is furnished in the natural color only and the sides average from 15 to 19 sq. ft. each.

84. Select and trace design (see Steps 1 and 2, Chapter I).

Floral designs with petals, stems and leaves are quite popular.

85. Cut leather to size (see Step 3, Chapter I, and Step 16, Chapter II).

The knife should be extremely sharp for cutting heavy leathers.

86. Dampen leather and transfer design to surface (review Steps 4, 5, and 6, Chapter I).

Carving cowhide absorbs a considerable amount of moisture and it is very important that the leather have a uniform moisture content for this type of work. In some leather shops, carving cowhide is immersed in water for several minutes, wrapped in a damp cloth, and left overnight. Some leathercraftsmen scrub the leather with soap and water. This removes all dirt or grime and softens the leather by opening the pores. As the beginning leathercraftsman works quite slowly at first, it may be necessary to dampen the leather from time to time as the work progresses. The leather may be first dampened by immersing it in water for from 15 to 20 seconds. Wipe off excess water with a cloth. Allow leather to stand for five minutes or more covered with a damp cloth before beginning work.

87. Cut design into leather with a swivel knife.

Holding the knife as shown in Fig. 102, cut the leather along the lines of the design. The blade of the knife may be turned between the thumb and second finger while a firm uniform downward pressure is maintained with the forefinger. The depth of cut should be approximately ⅓ of the thickness of the leather. Tilt the knife slightly away from you to raise the heel of the cutting edge and pull the knife toward you.

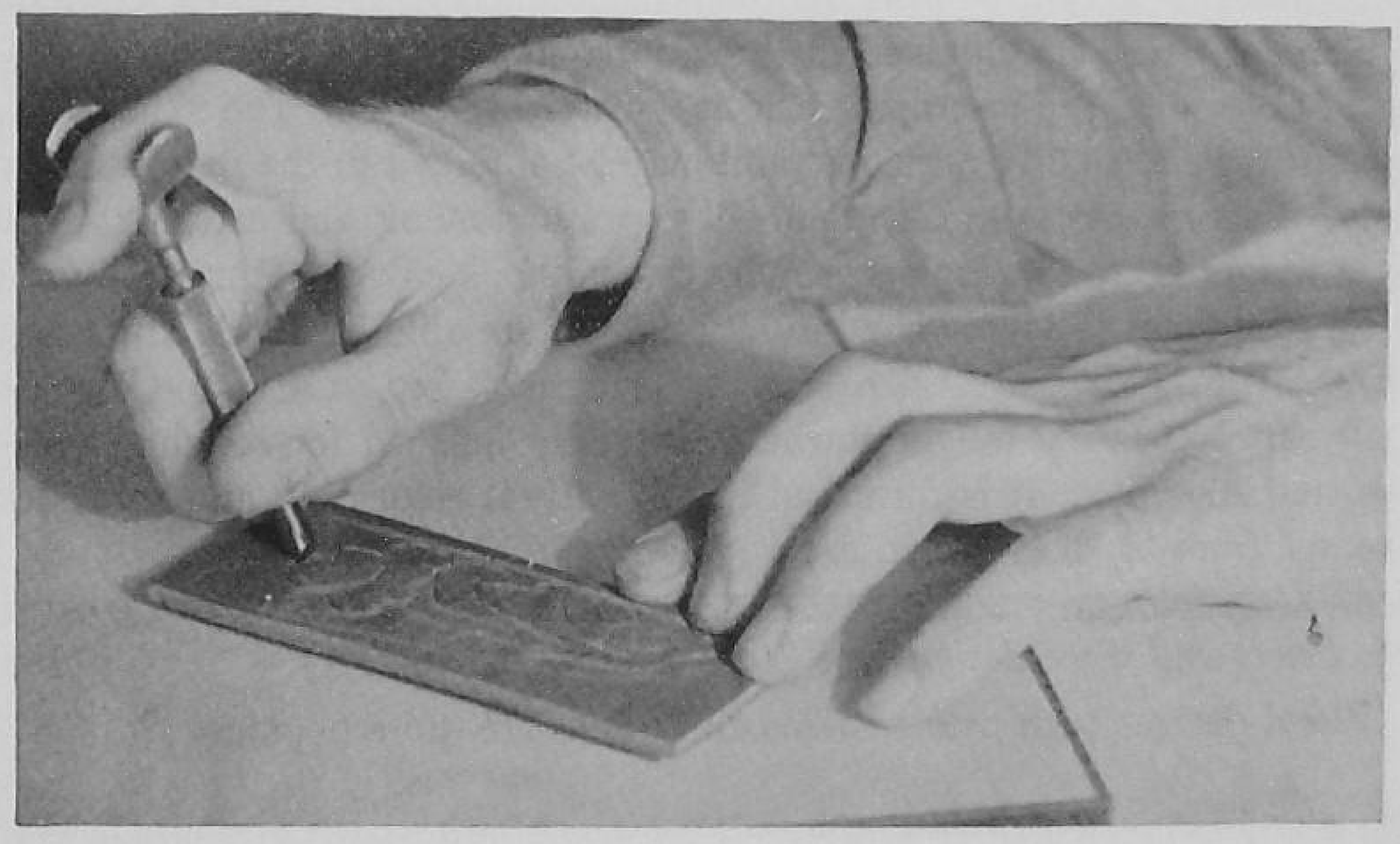


FIG. 102.

Incise the major lines of the design. It may be desirable to tool veins of leaves, etc., rather than cutting them. Any line which is not incised may be tooled with the modeler. At points of intersection, lift the knife and begin again on the other side. DO NOT CUT ACROSS A PREVIOUS CUT.

Cutting is the first fundamental of incising and is rather difficult. It would be well for the beginner to practice on scrap pieces before beginning work on the project.

88. Bevel cut edges.

Open out the cut by pressing down the cut edge of the background with the spoon end of the modeling tool (see Fig. 103). Use a sliding sidewise movement with considerable pressure. Reverse the procedure, using less pressure, on the cut edges of the design. This will make the edges more even.

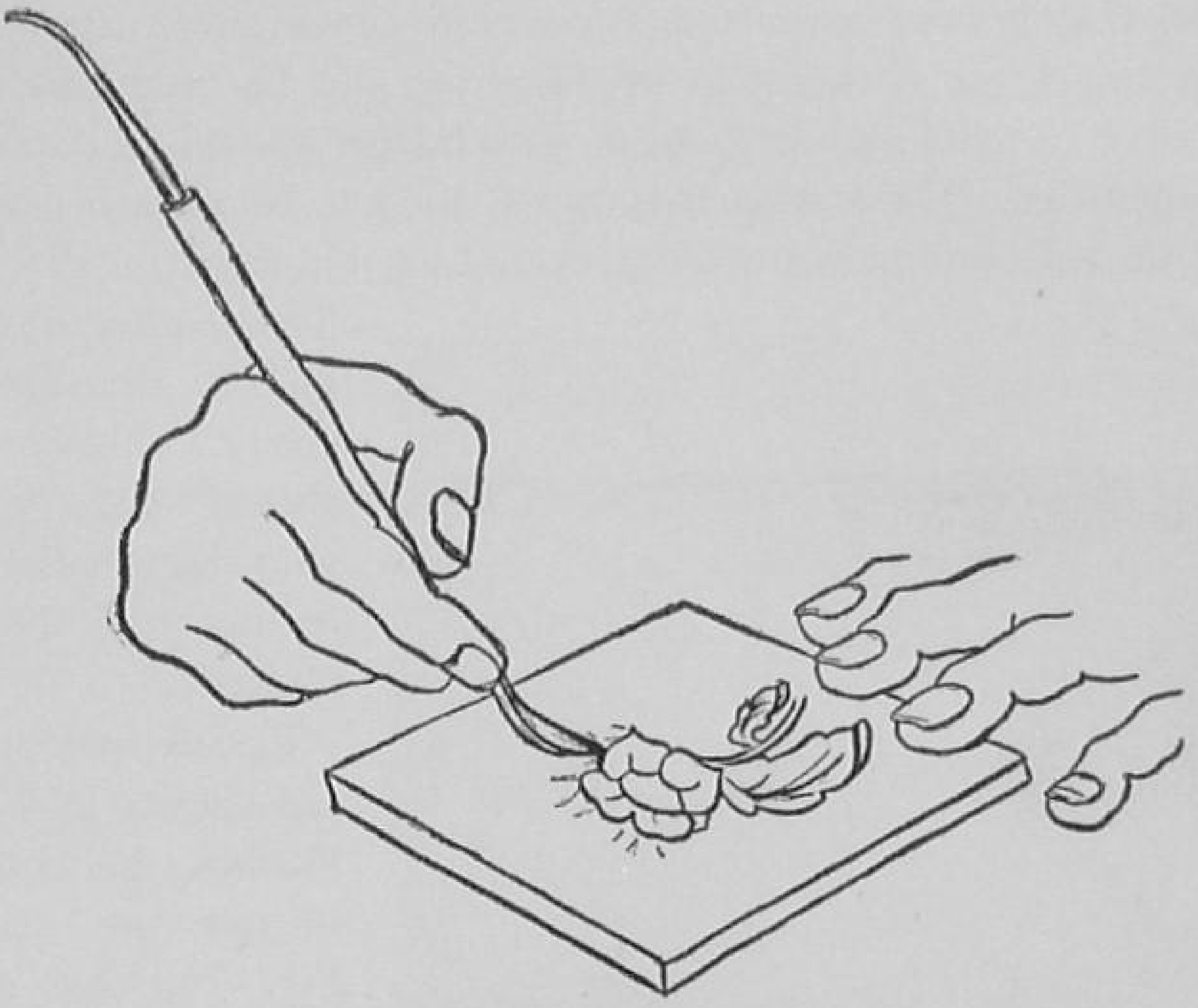


Fig. 103.

89. Stamp background.

Hold the stamp firmly between the thumb and fingers of the left hand in a vertical position. Strike the end of the stamp with a mallet (see Fig. 104). It is important that the background be depressed to a considerable

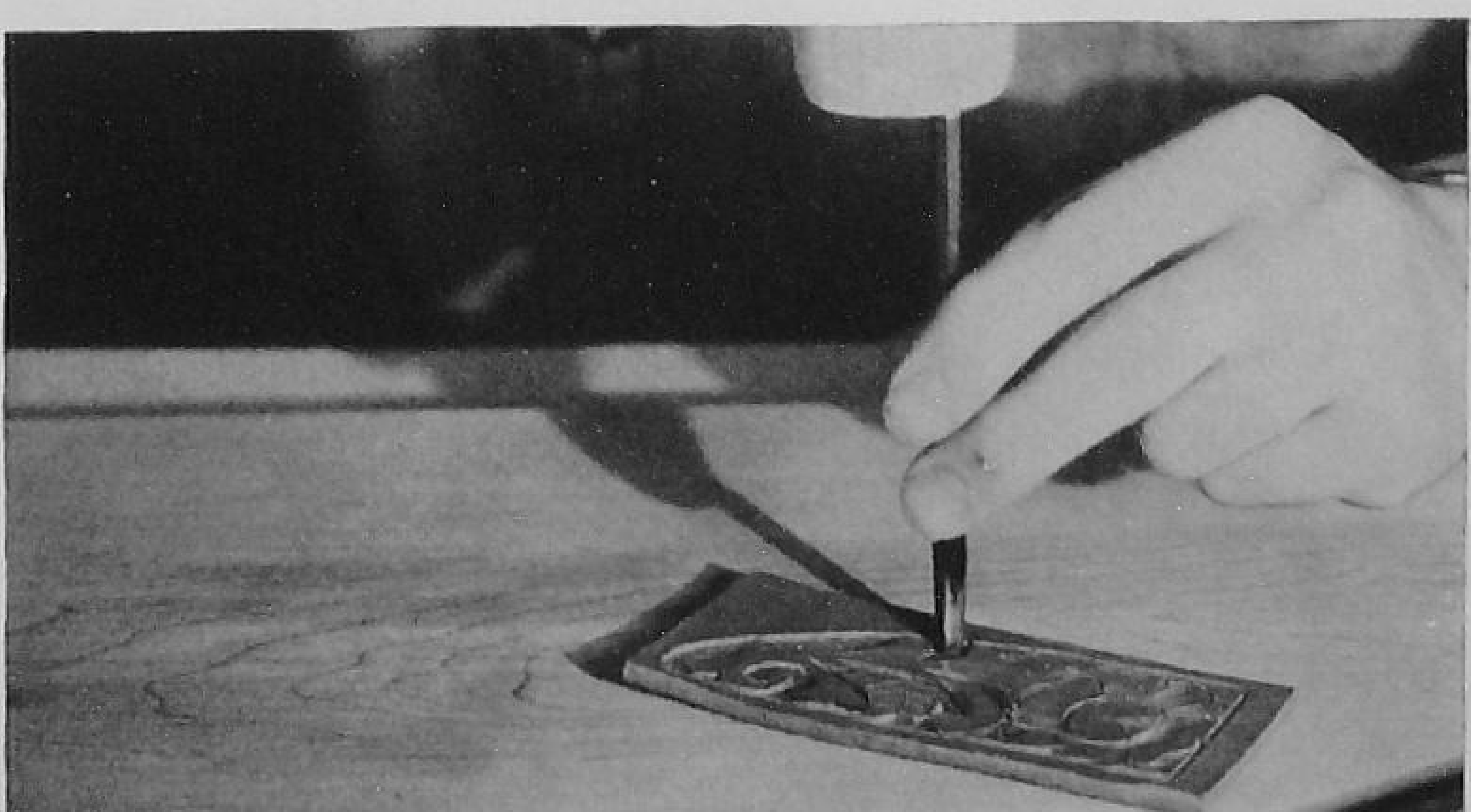


Fig. 104.

depth and that it have a uniformly textured appearance. Stamp only a small portion of the background at one time and be very careful when working close to the design or border. The leather should be partially dry for this operation. The leather may again have to be slightly moistened, however, as uniform backgrounding cannot be obtained on dry leather. The leather should not be too wet and excessively heavy blows should not be struck with the mallet as the leather may be cut or marred.

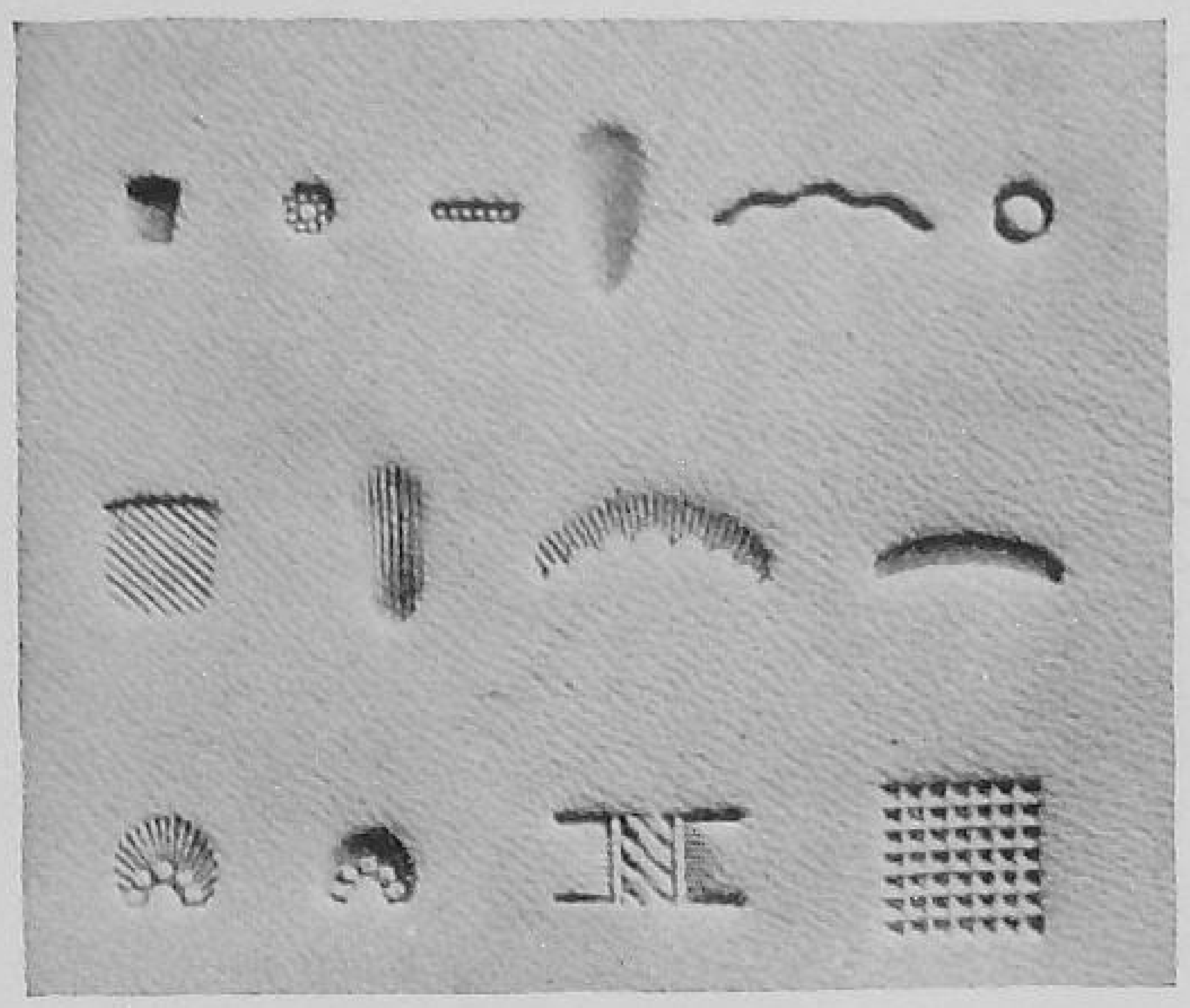


FIG. 105. Carving stamps.

Various carving stamps are shown in Fig. 105. Various backgrounding stamps are shown in Fig. 74. An excellent background may be obtained by using a set of metal matting tools.

A very beautiful effect can be obtained if the stamped background is dyed brown.

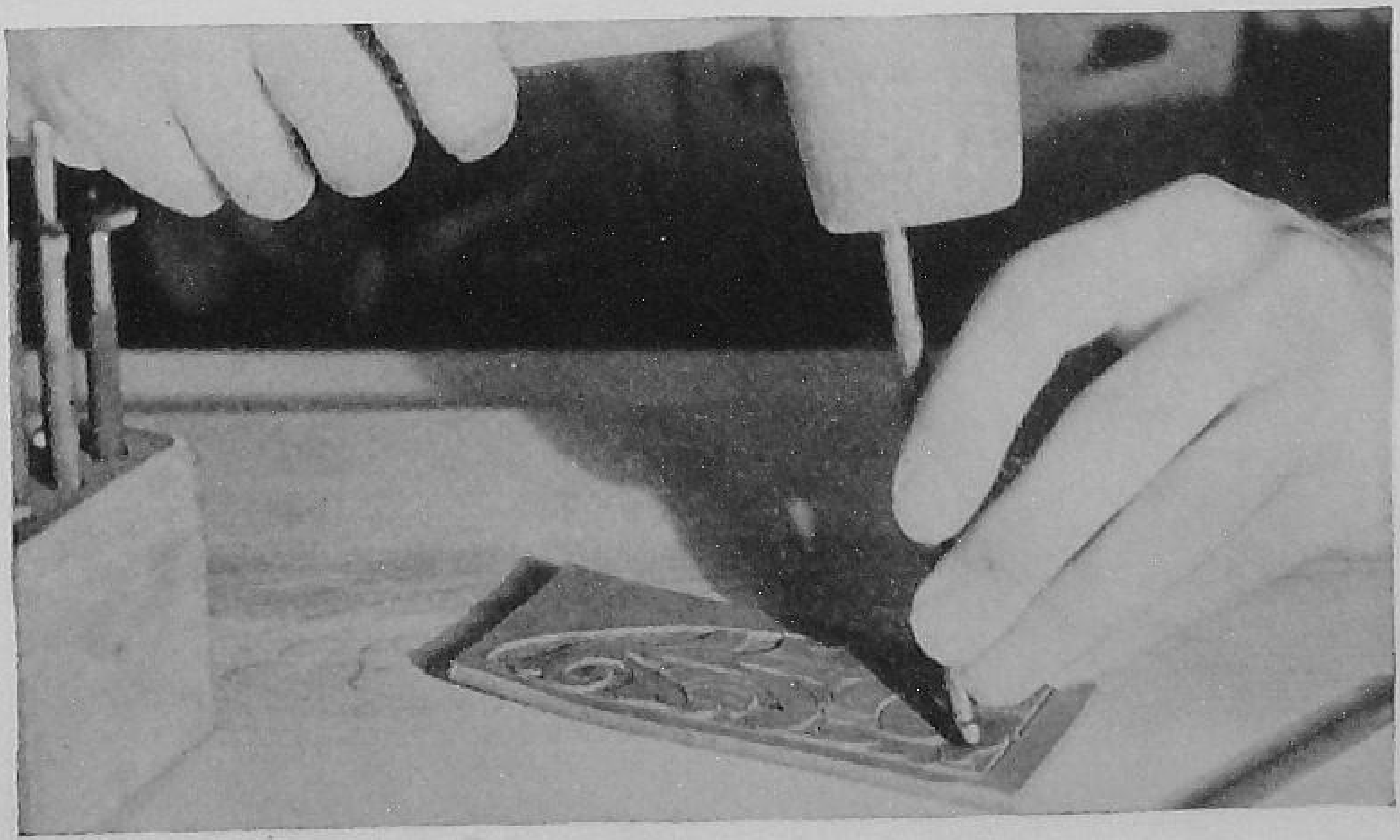


FIG. 106.

Fig. 107.

90. Stamp design (see Fig. 106).

Further decoration and form may be applied by stamping the design with the carving stamps shown in Fig. 105. Almost all flower petals and leaves are shaded. The shading stamp should be tilted away from you and struck sharply with the mallet. Gradually tilt the tool toward you, striking more gently. The pear shaped depression will thus be tapered.

The leather craftsman must use imagination in the selection of the stamp

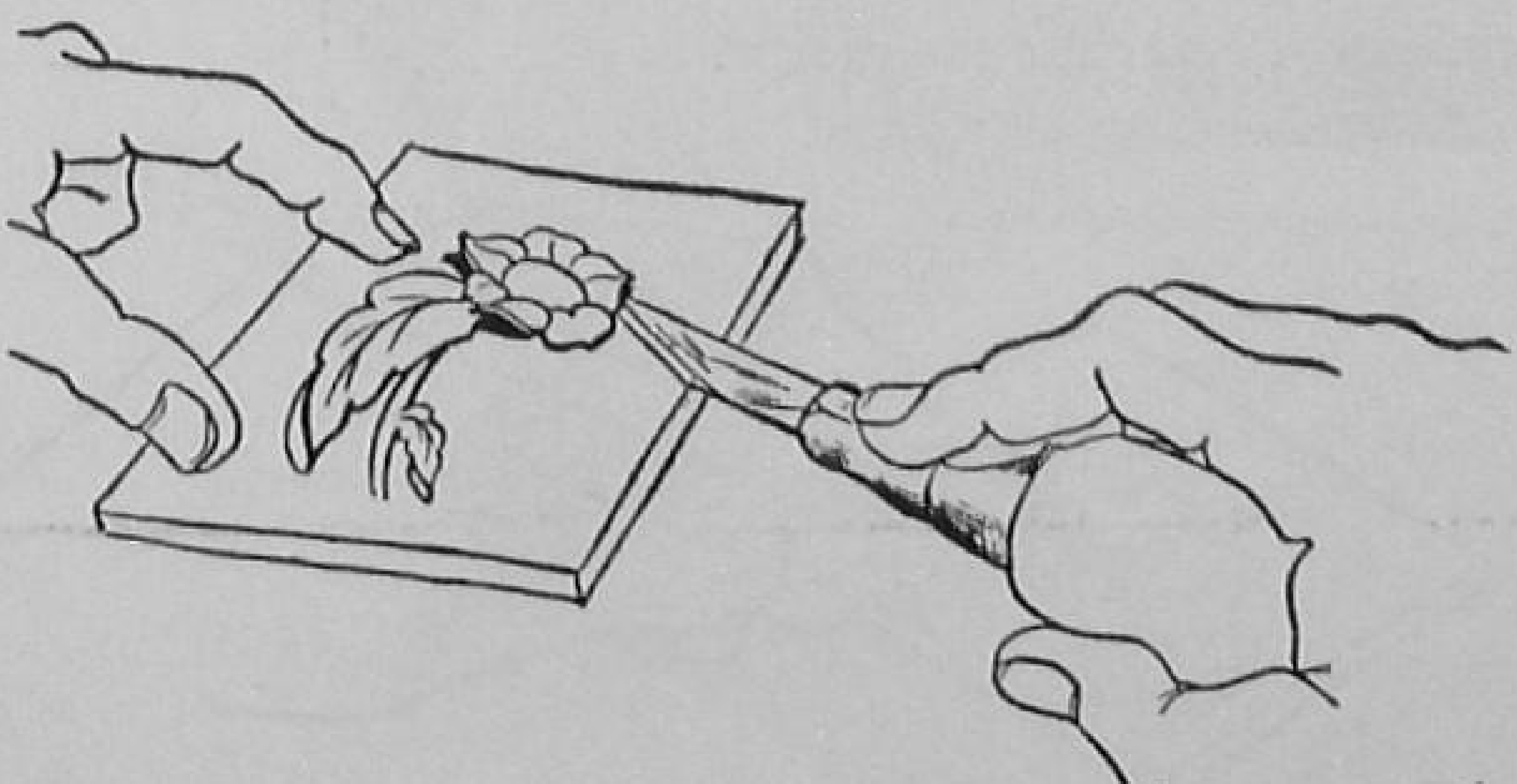


Fig. 108.

FIG. 109.

to be used. Although the design is in comparatively low relief, a skill comparable to that required for clay modeling is necessary. To raise the design to a higher relief (carving), undercutting and filling are necessary.

91. Carve design.

Again dampen the leather. Select a slender pointed knife with a very sharp cutting edge. Cut under the various parts of the design which are to have a curved or raised effect (see Fig. 107). Usually the upper one-third of the leather thickness is raised. Use a slicing type of motion as indicated in Fig. 108. Great care must be taken in the cutting operation to avoid ruining the entire project. With a small brush, dampen the inside of the leather which has been cut. Roll the small end of the ball modeling tool under the area cut and raise the design.

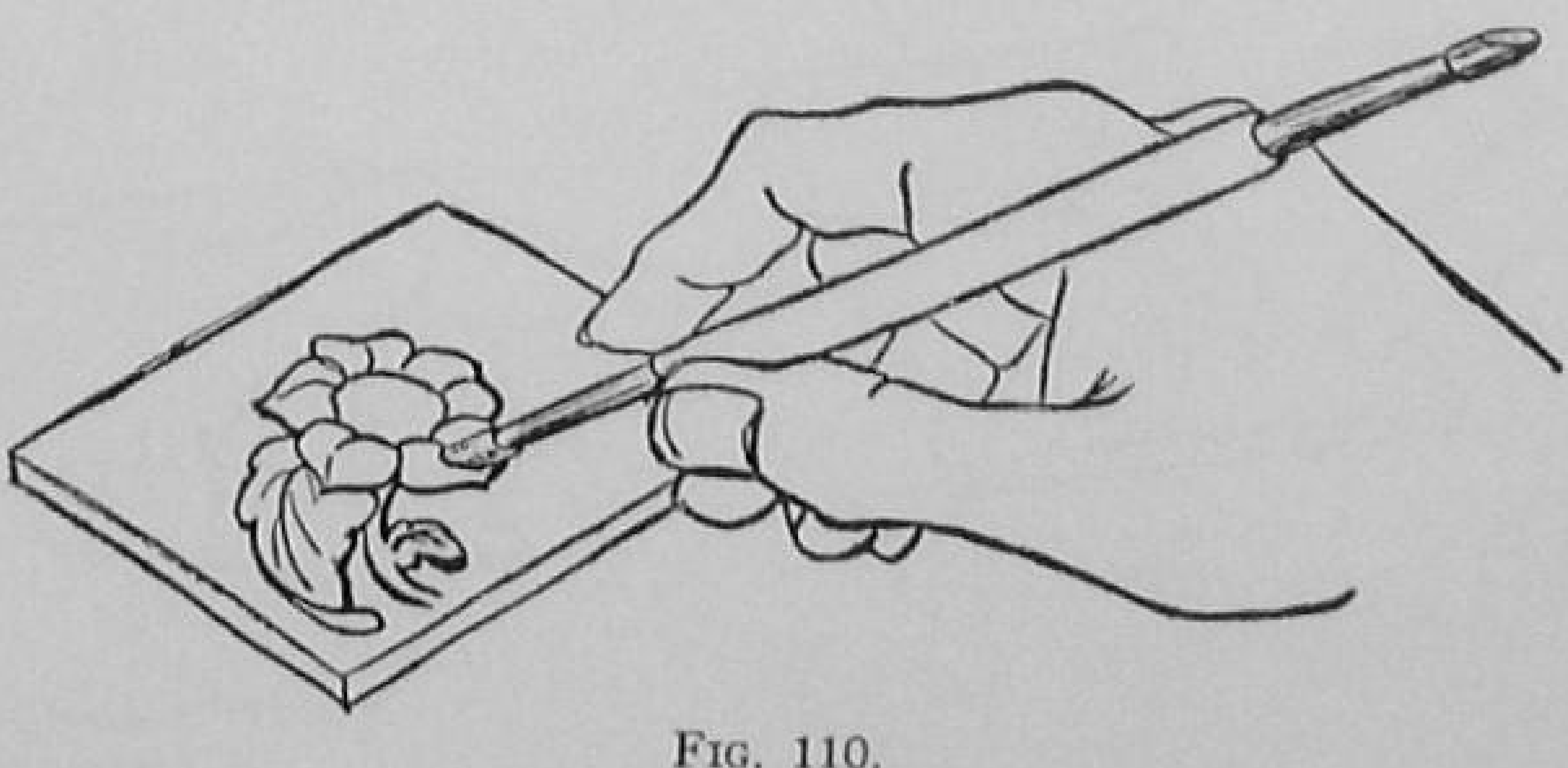


FIG. 110.

Some leathercraftsmen use a lancet for carving leather. This is a fairly long tool with a slightly curved blade on one end and a small ball on the other.

Allow leather to dry. Spread cement in the interior of the cut and fill the raised area with small pieces of cotton or similar packing material which has been dipped in leather cement. Use tweezers for the packing operation (see Fig. 109). Only enough packing should be used to support the contour created by the rolling technique. Allow cement to become tacky. After inserting a desired amount of filling, press the leather back into place. The deer foot modeling tool may be used to smooth the edges of the design and to slightly remodel any part of the raised portion (see Fig. 110). Fig. 111 shows a stained and carved knife sheath.

The petals of the flower have been raised by carving.

FIG. 111.

92. Finish project by lacing, cleaning, and polishing.

Chapter VIII

HOW TO MAKE BRAIDED AND LINK BELTS

Braided belts are generally made from stranded leather. Three, four, five, six, eight, and ten strands are the most common. The belts are cut from cowhide and may be purchased already slit for braiding. The strap ends are finished, trimmed and punched, and the lacing, buckles, buckle flaps, and patterns are supplied with each belt.

Belts may be cut from whole skins and stranded by the leathercraftsman.

93. Cut belt with Gage Knife.

Set the gage knife to the correct width and tighten the thumb screw. Grasp the gage knife by the pistol grip in the right hand and place the fence alongside the straight edge of the leather skin. Pull the knife toward you as shown in Fig 112.

94. Slit leather belt to desired number of strands.

This may be done by the gage knife as described in Step 93, adjusting the knife after each cut. Stranding, which is similar to fringing (see Step

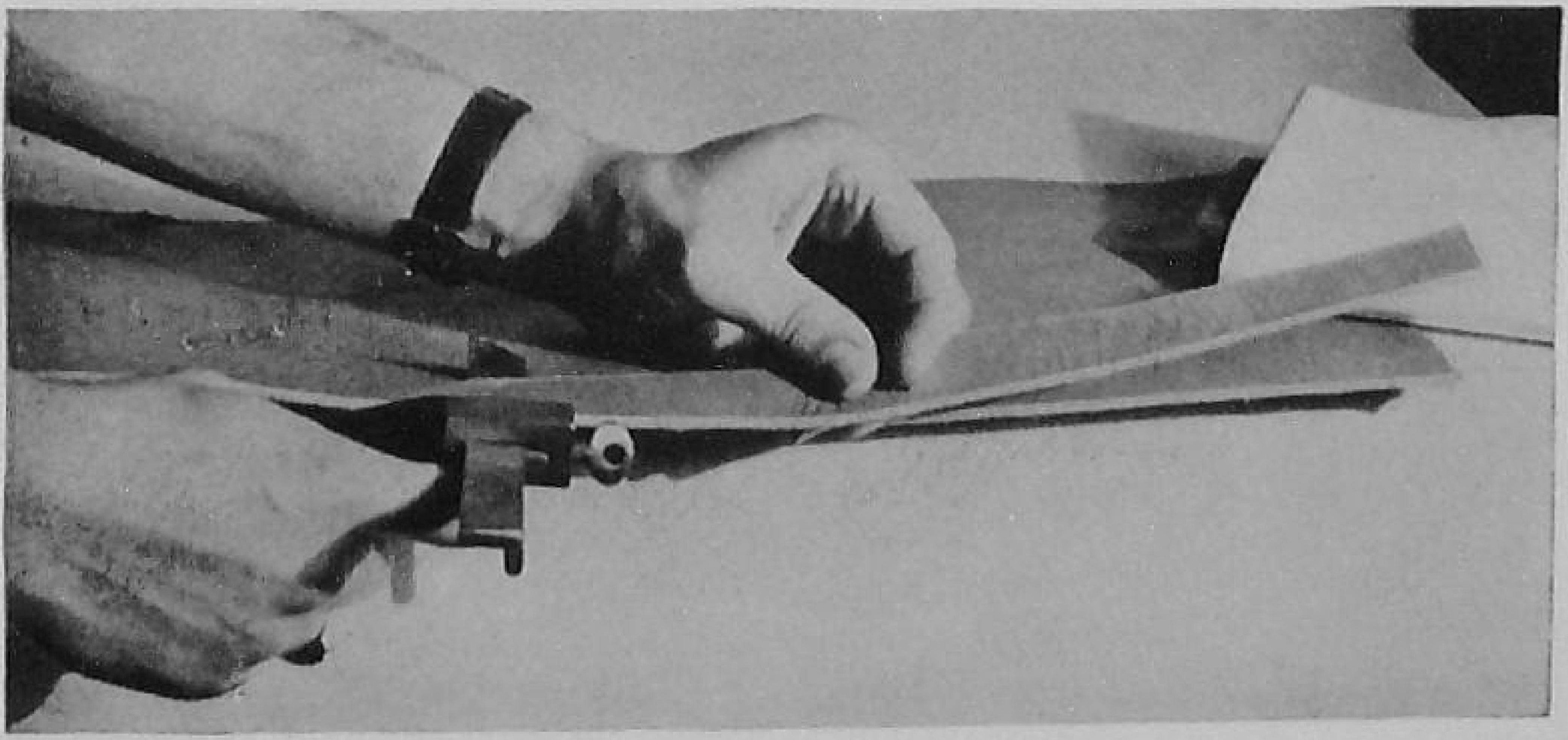


Fig. 112.

9, Fig. 8, Chapter I), may also be done by using a very sharp cutting knife and a straight edge. It might be wise to employ extra help to keep the straight edge from slipping. A better method is to make the stranding cuts before separating the belt from the skin. Strand the belt up to approximately 6″ of one end. This end will be the strap end of the belt and may be cut and punched similar to the one shown in Fig. 113.

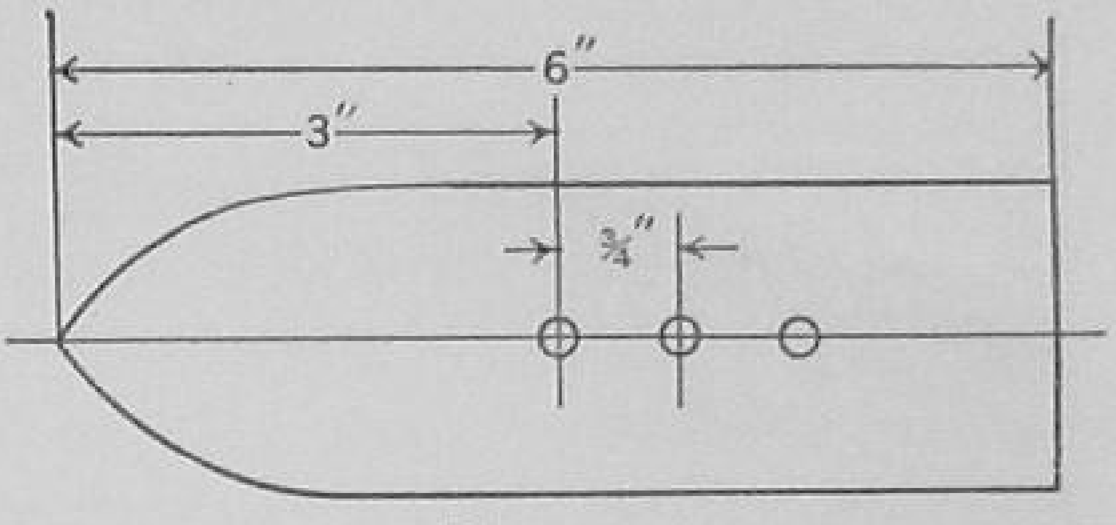


FIG. 113.

95. Bevel all exposed edges of the leather.

The sharp edges of the leather, both top and bottom, should be removed with an edge beveling tool (see Fig. 114) to keep the edges from curling. Holding the edge beveler in the right hand, place the V-shaped cutting end on the sharp edge of the leather at approximately the angle shown in Fig. 115. Push the tool forward, cutting a thin continuous shaving from the edge (see Fig. 115). If the tips of the ring finger and little finger of the right hand are lightly pressed against the edge of the leather, and the backs of these two fingers are allowed to rest lightly against the top of the cutting board, the exact position of the tool will be maintained and a continuous stroke will be made possible. Hold the leather from slipping with the fingers of the left hand (see Fig. 115) and avoid any irregularities in the cut.

FIG. 114. Professional type edge beveler.

96. Braid six-strand belt using the cross-over braid.

The cross-over braid may be done with belts having an even number of strands such as four, six, eight, and ten. Fasten the uncut end or belt strap to a table or bench top with a clamp (see Fig. 116). Protect the leather from the jaws of the clamp by using a small piece of wood or heavy cardboard.

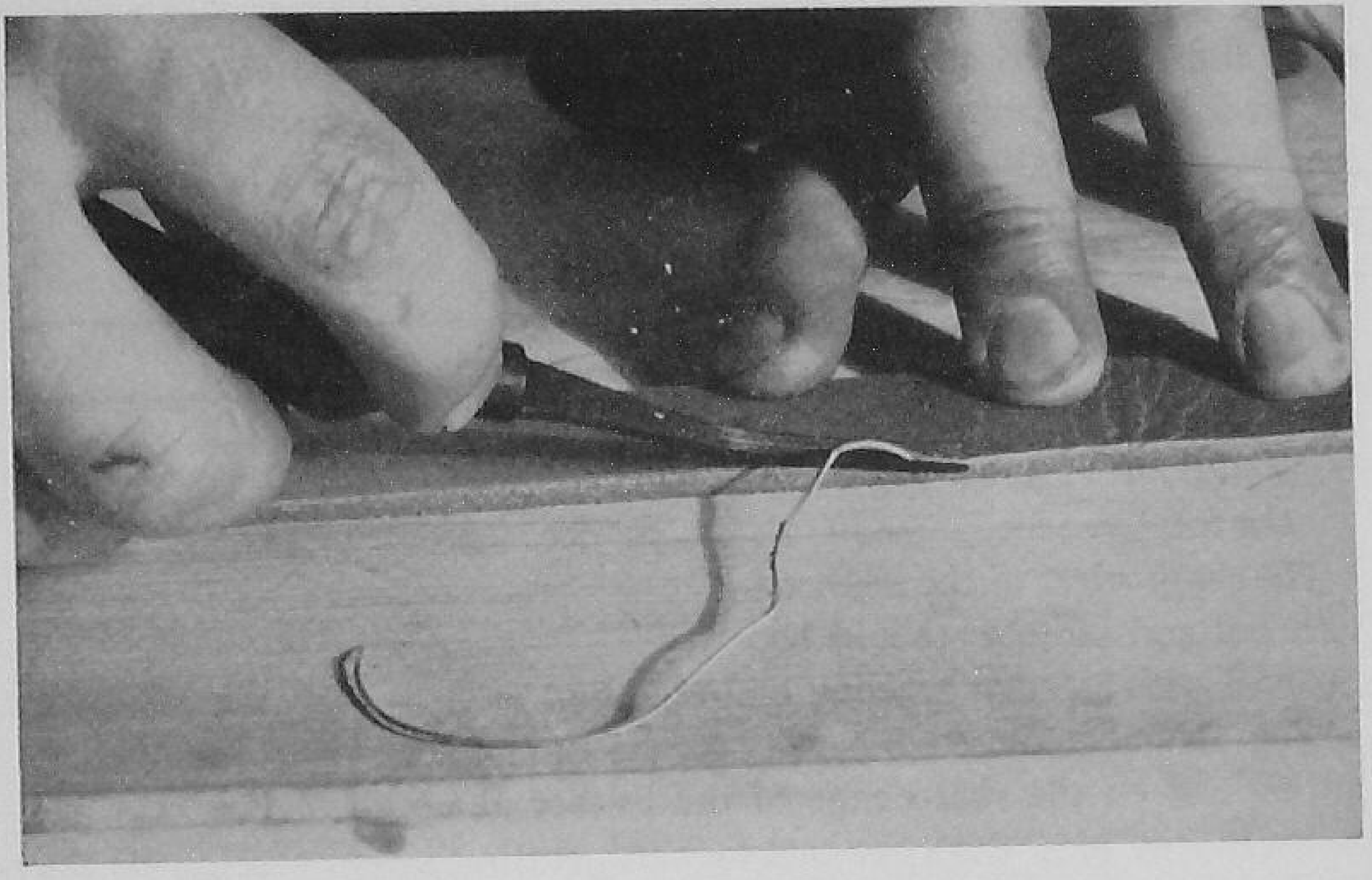


Fig. 115.

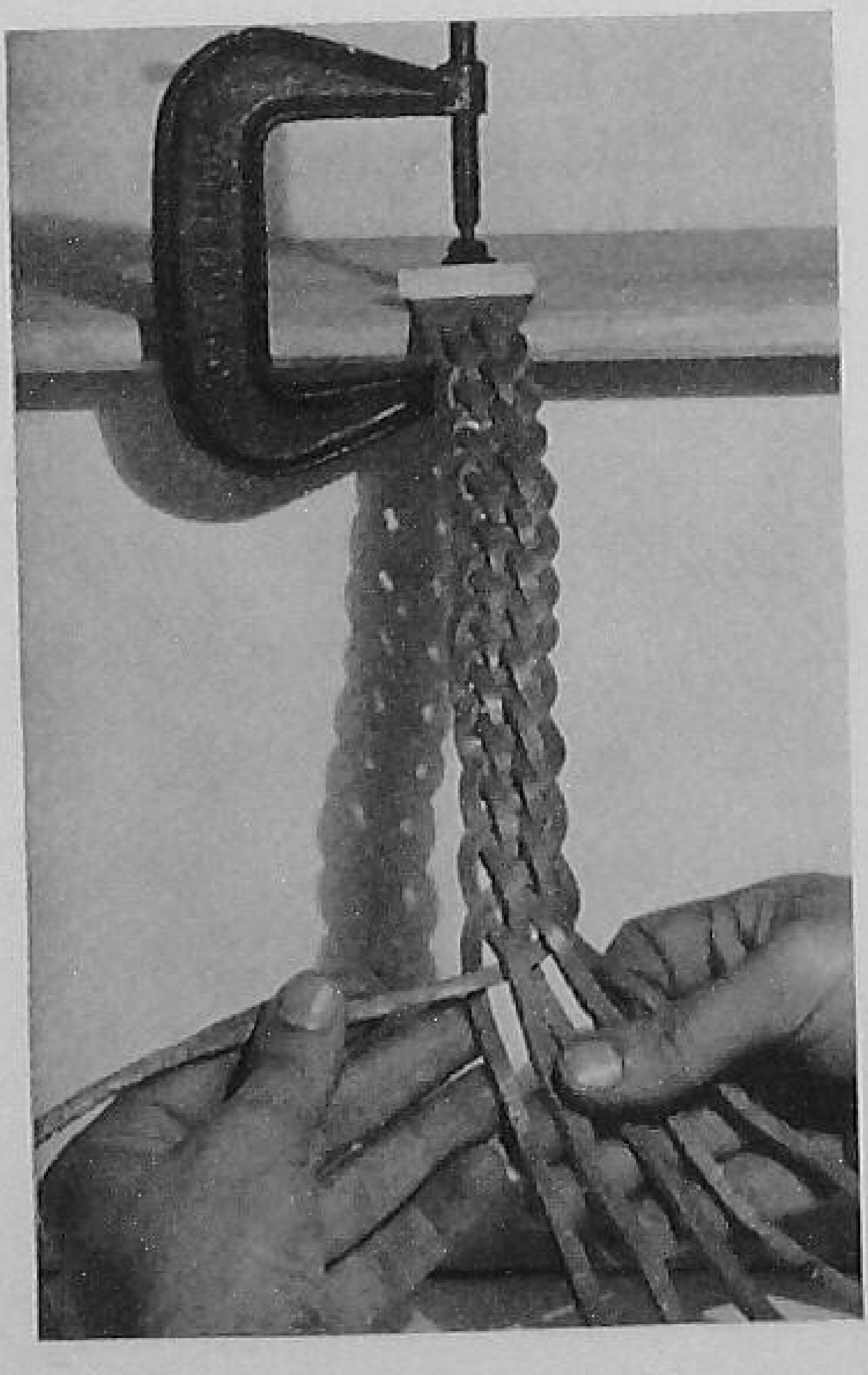


Fig. 116.

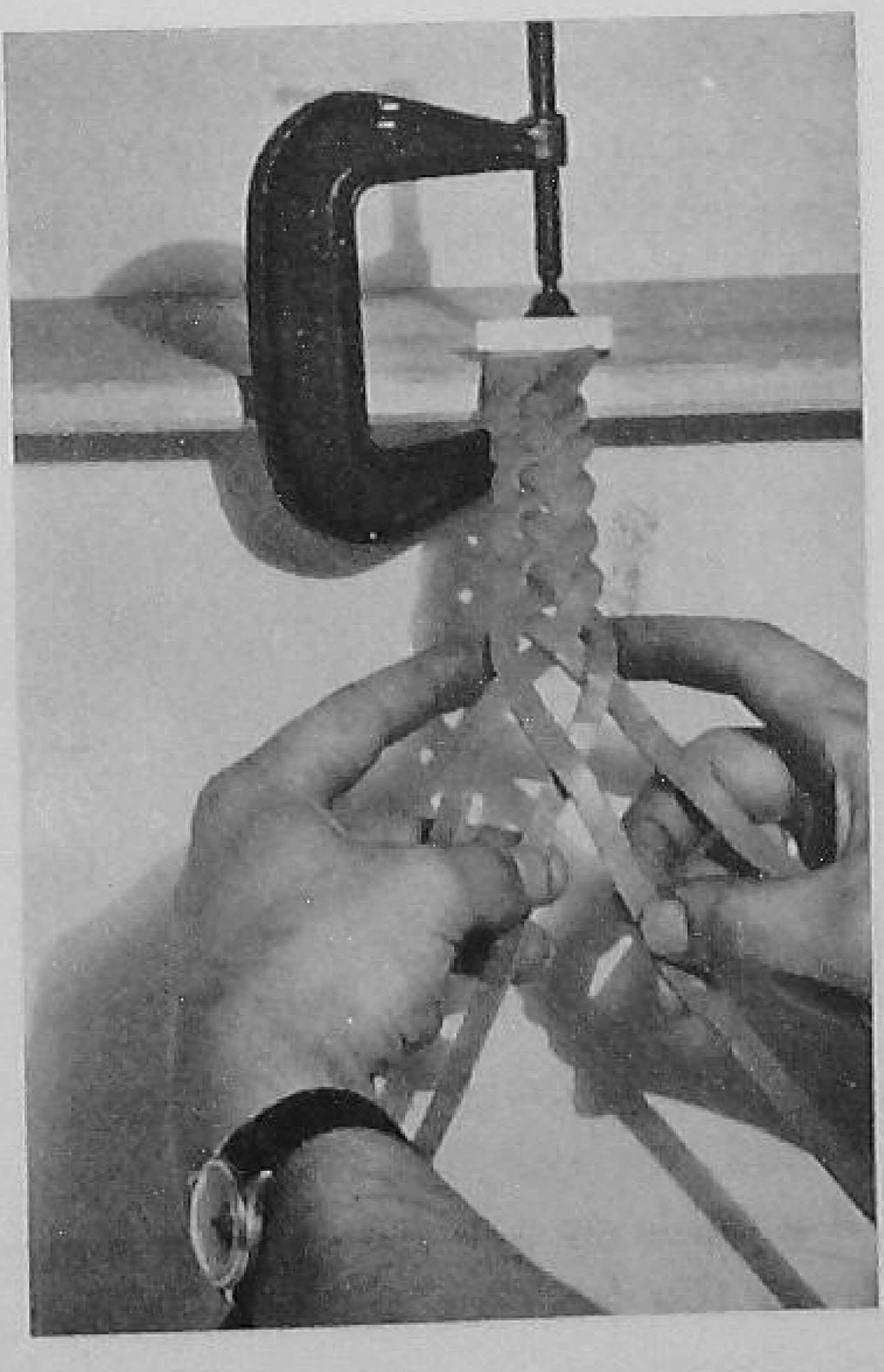


Fig. 117.

Take the *first strand* on the right hand side and weave it over the second, under the third, over the fourth, under the fifth, and over the sixth (see Fig. 116). Let the strand hang.

Take the next strand on the right-hand side and weave it across. This was the *second strand* when you first began and it will now be laying over the *first strand* on the left hand side as indicated by the strand which is held in the left hand shown in Fig. 116. MAKE SURE THE STRAND WHICH IS WOVEN OVER FROM THE RIGHT LAYS OVER THE LAST STRAND ON THE LEFT.

Continue the braiding tightening the strands as you progress. Always weave from right to left. When the strands are completely braided hold the ends from unraveling with a spring clamp or an elastic band.

97. Braid four-strand belt using the four-strand interlocking braid.

Secure the strap end as explained in Step 96. Take the outside right-hand strand and place it *over* the strand next to it. Take the outside left-hand strand and place it *under* the one next to it. The two original outside strands will now be in the middle. Cross these two middle strands by passing the right under the left (see Fig. 117). Continue the braid and fasten

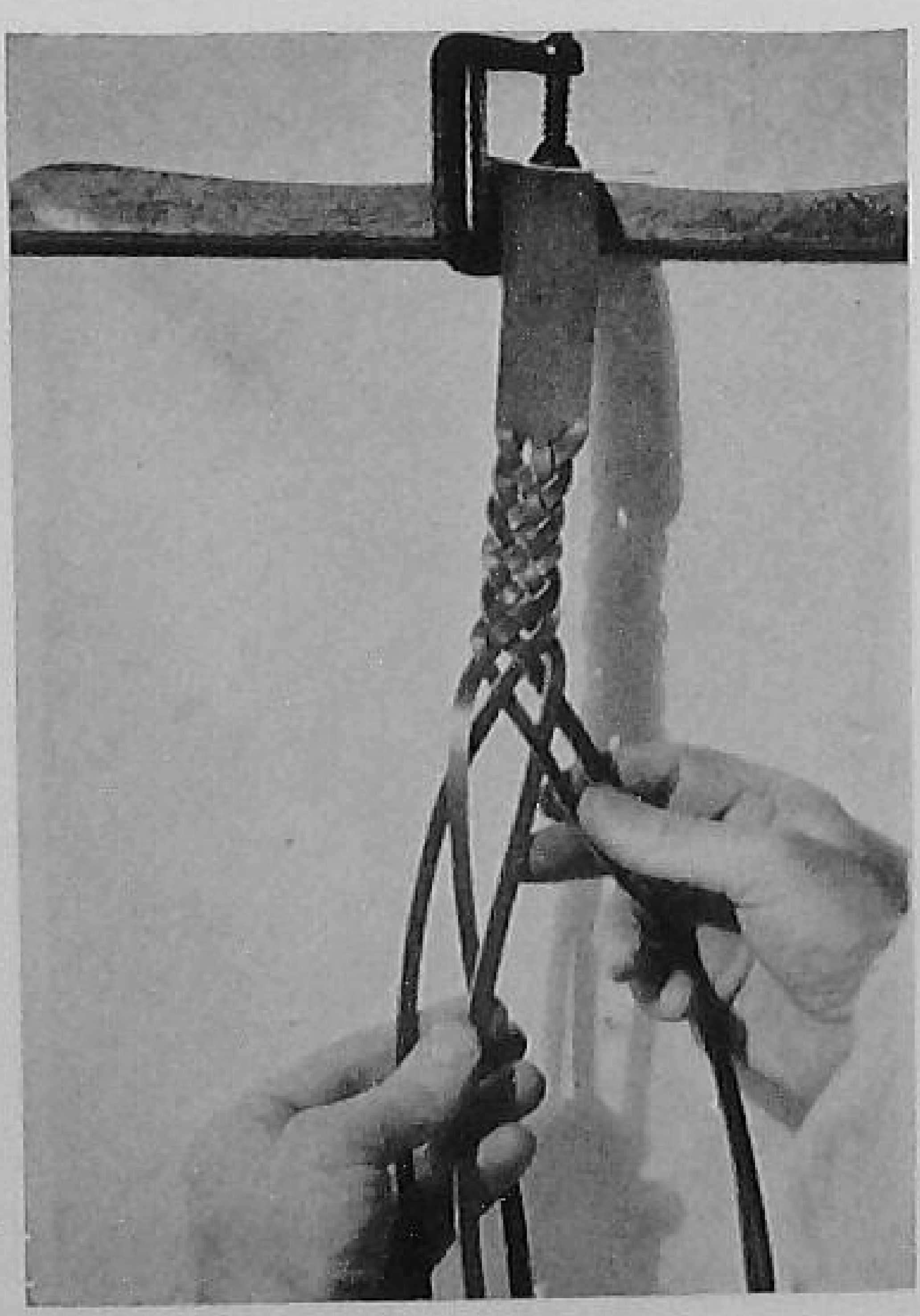


Fig. 118.

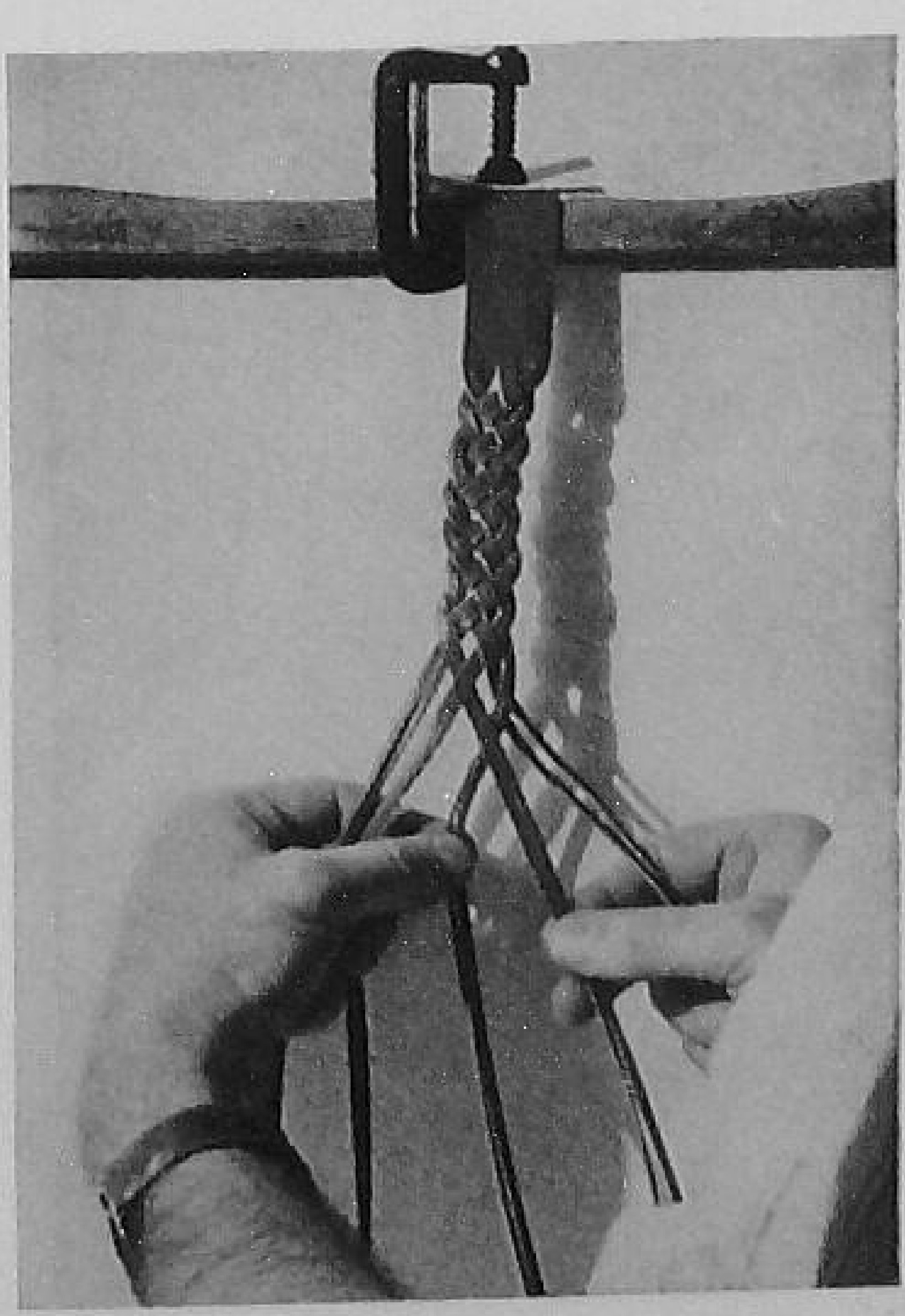


Fig. 119.

the finished ends as explained in Step 96. This is an extremely fast type of braiding and may be manipulated by both hands.

98. Braid a five-strand belt.

Start by passing the right outside strand to the left, over one strand and under another. Then pass the left outside strand to the right, weaving it over one and under another (see Fig. 118). Continue the braiding, weaving first from right to left then from left to right.

A ten strand belt may be woven in a similar manner by pairing the strands. This produces a double five-strand braided belt. Two strands are always held together and counted as one strand (see Fig. 119).

99. Make a three-strand braided belt.

This is the simplest of all braided belts and is performed in exactly the

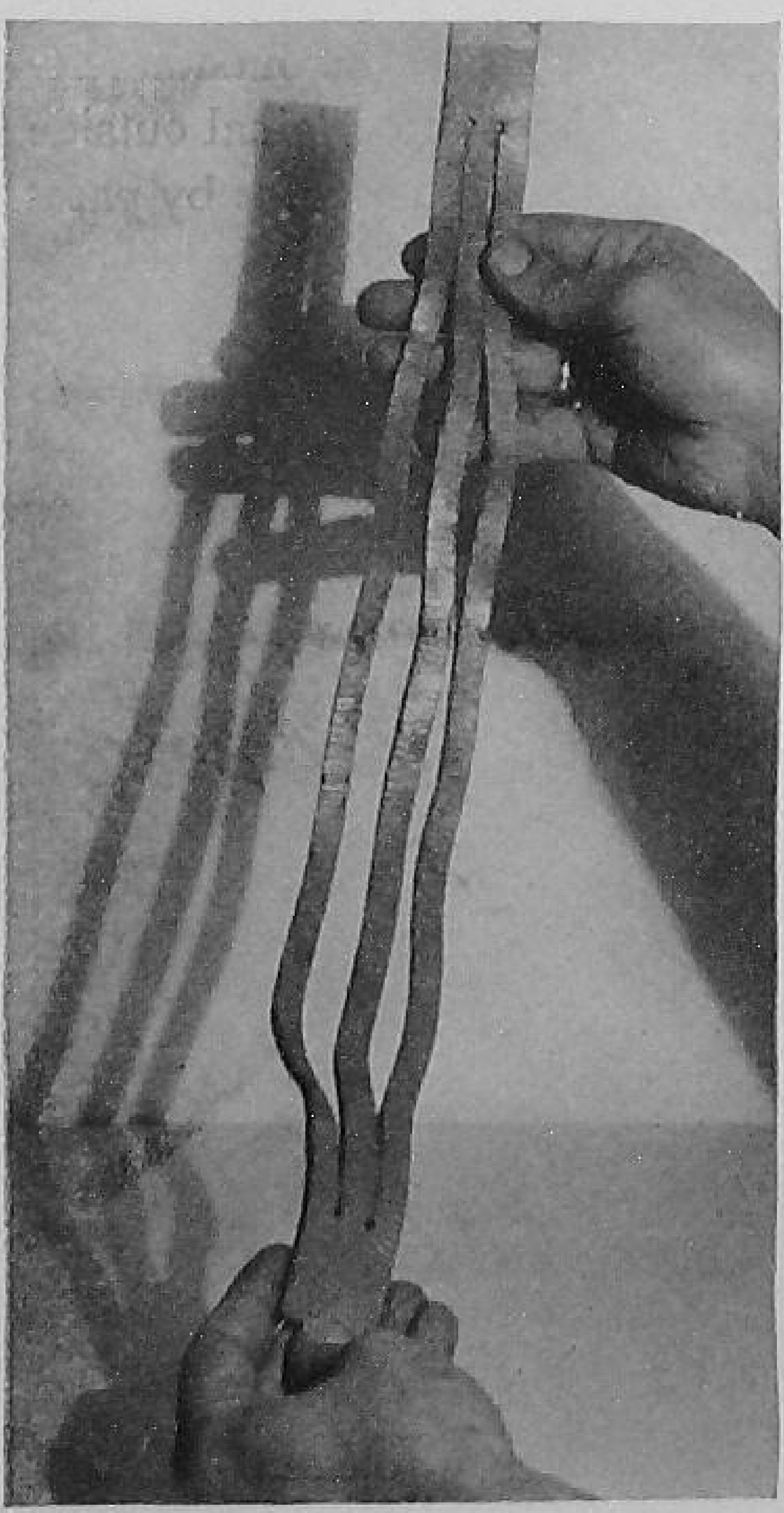


FIG. 120.

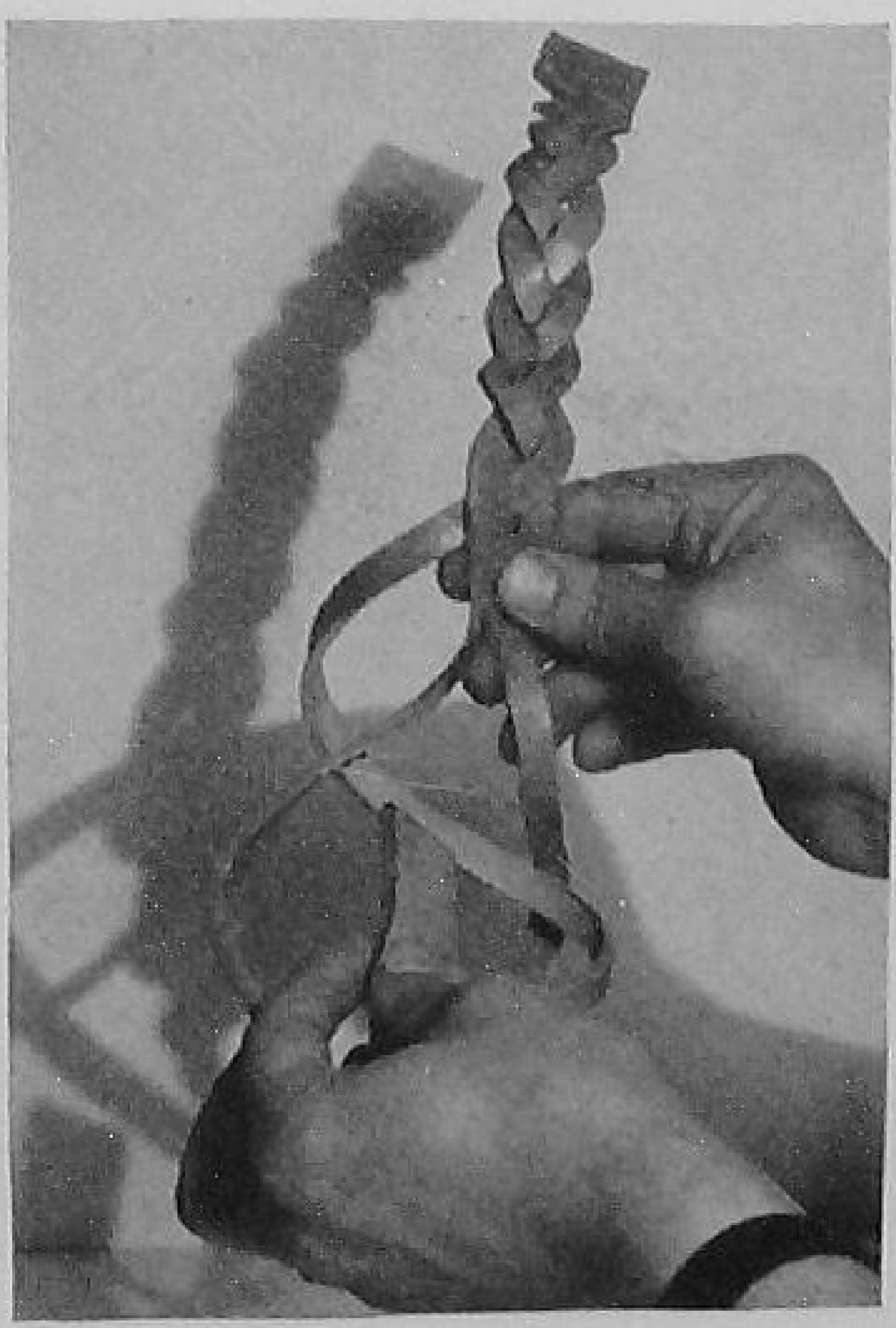


FIG. 121.

same manner as some women braid "pigtails" with their hair. Start by passing the right outside strand to the left and over the middle strand. This strand now becomes the middle strand. Now pass the left outside strand to the right and over the middle strand. This strand now becomes the middle strand. Continue the braiding, working first from the right and then from the left until the entire length has been completed.

100. Make a three-strand "blind" braided belt.

Both ends of this belt are closed (see Fig. 120). Weave the belt as described in Step 99. After three motions of braiding it will be noticed that the bottom of the belt has become twisted or tangled. Holding the braided portion tightly with one hand, untangle the lower end of the belt by passing the bottom of the belt up and through the large tangled loop as shown in Fig. 121. Braid the belt as far as possible, pulling each braid as tightly as you can as you work. The last few braids will necessarily be a little

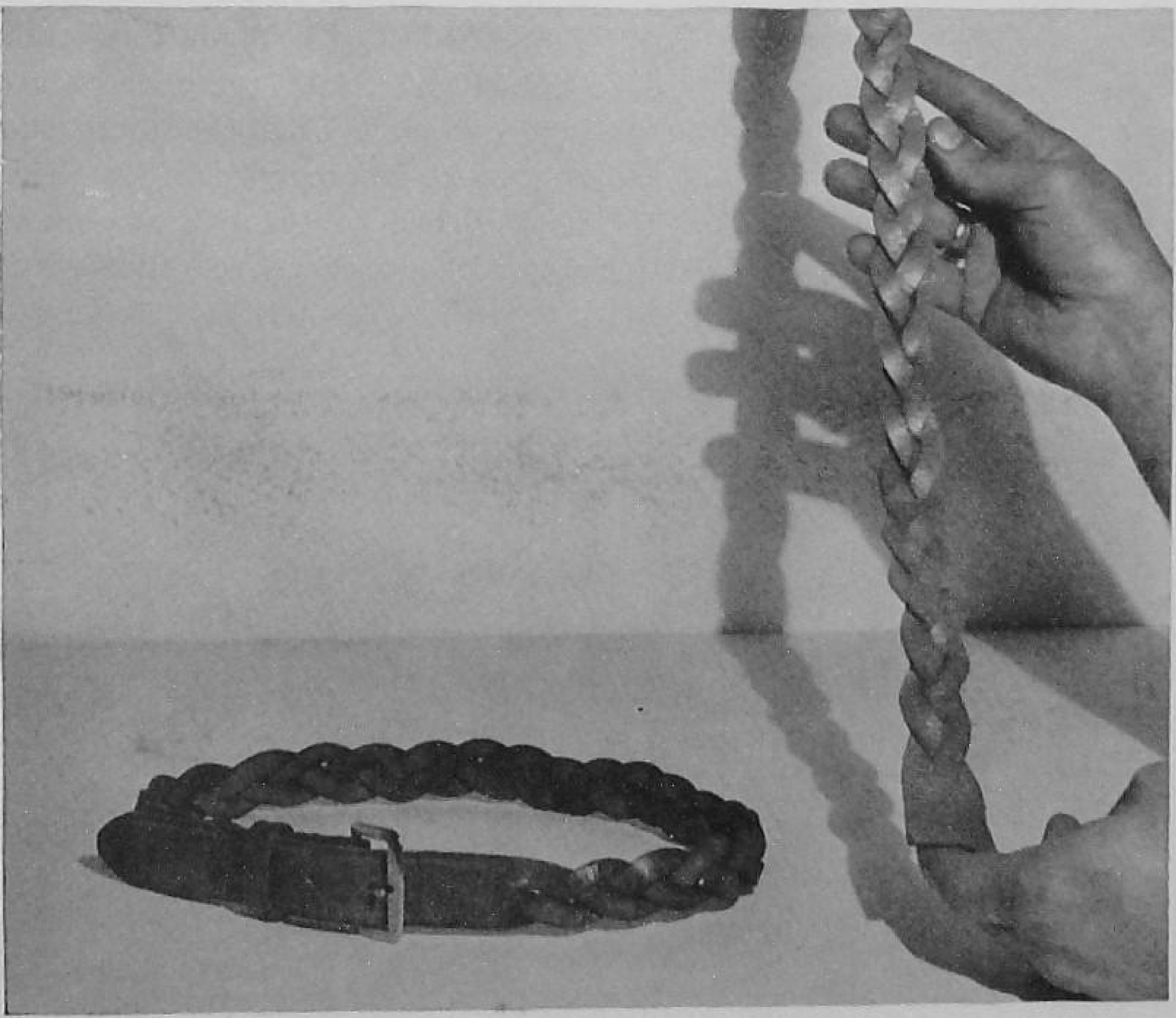


FIG. 122.

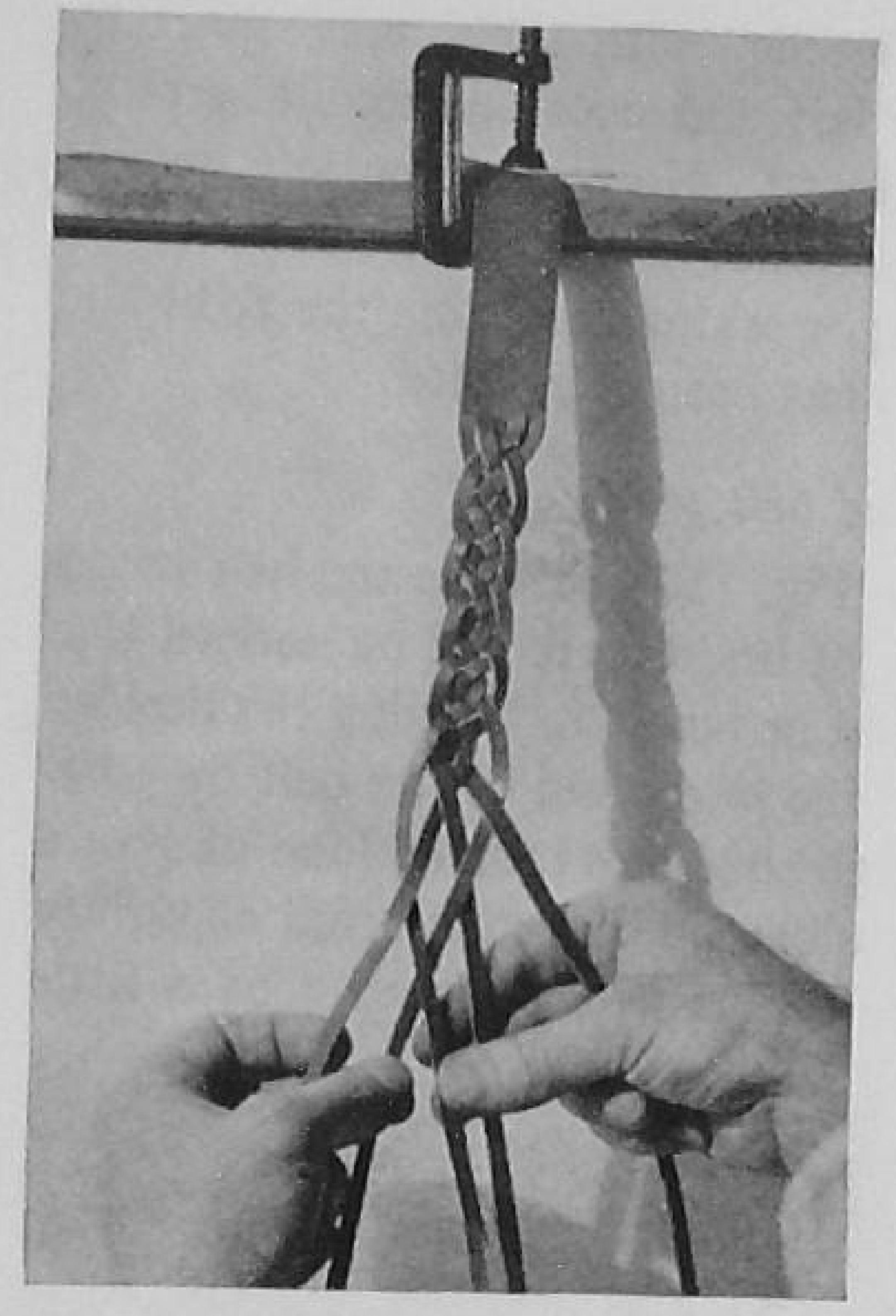


Fig. 123.

loose. Distribute this slack evenly throughout the belt by pushing the tightly braided area downward with the fingers. A completed belt is shown in Fig. 122.

101. Braid a belt using the fancy five-strand braid.

Make a complete step of the three-strand braid with the three center strands. See Step 99. Take the right outside strand and pass it to the left and under the strand next to it. Take the left outside strand and pass it to the right and under the strand next to it. Cross these two in the center as shown in Fig. 123. Again complete a three-strand braid using the three center strands. Braid the two outside strands as before, passing the right-hand strand to the left and under one and the left-hand strand to the right and under one. Cross the strands in the middle. Continue braiding until the belt is complete.

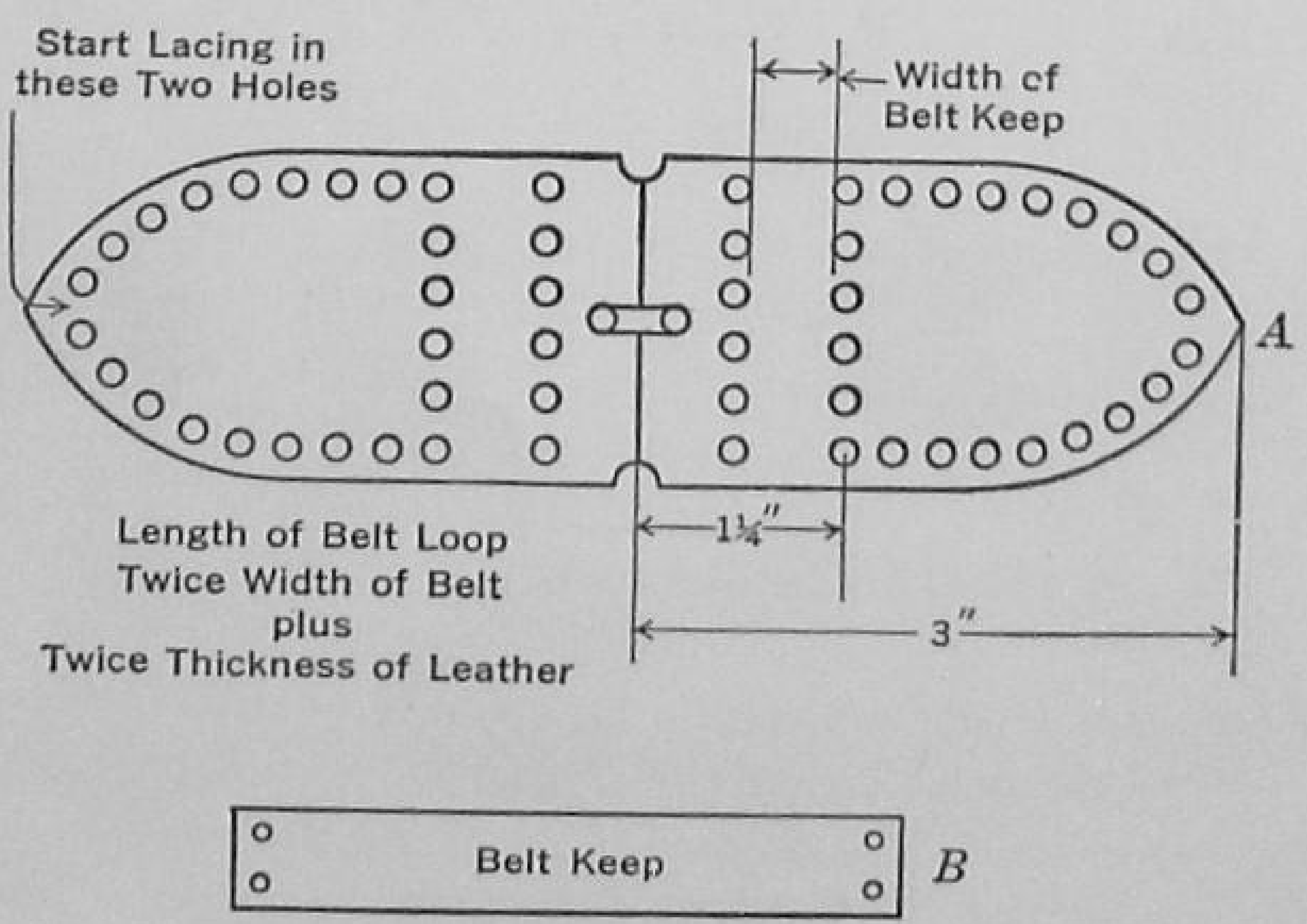


Fig. 124.

102. Make buckle ends and keeps for braided belts.

A suggested buckle end is shown at *A*, Fig. 124. Cut leather to size and shape. Skive all edges. Cut buckle slot for tongue and knuckle of buckle and notch edges for buckle frame. Punch all lacing holes as shown.

A belt keep must be made and may be cut similar to the pattern shown at *B*, Fig. 124. Punch two holes in each end. Butt the ends together and fasten the ends with lace as shown at *C*, Fig. 101, Chapter VI.

103. Attach belt to buckle end.

Measure the length of the belt from the tip of the strap end to the end of the braid. The measurement should be from 1½″ to 3″ longer than the waist measurement. Trim the ends of the braid square at this point.

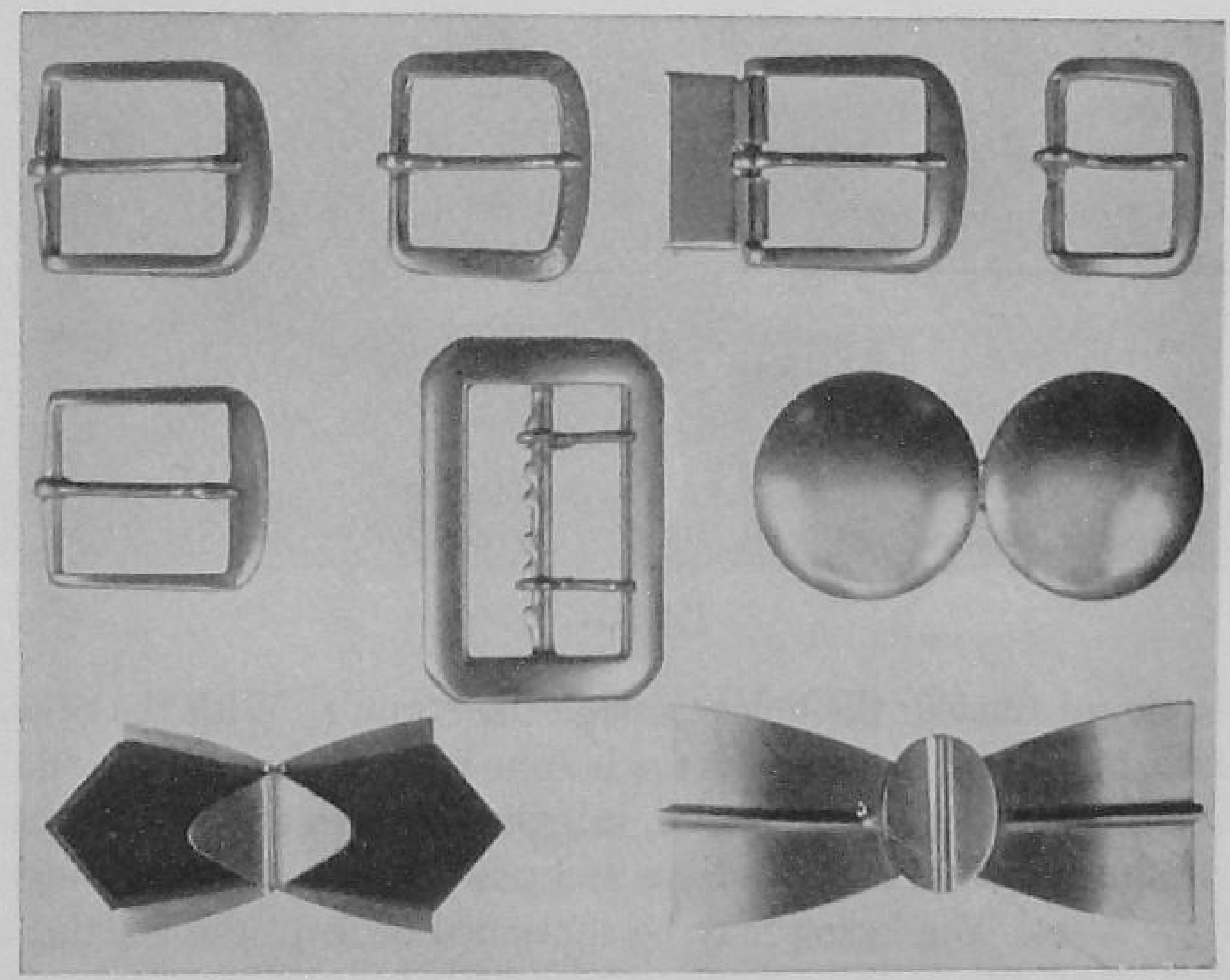


Fig. 125. Buckles.

Slip the buckle (see buckles, Fig. 125) into position with the tongue through the buckle slot. Slip the belt "keep" over one end of the buckle end making sure the laced ends are on the inside and that the keep is between the two vertical rows of holes. Apply cement to the inside of the buckle end and insert the trimmed end of the braided belt up to the first

row of vertical holes. Press the ends of the buckle ends together and allow to dry for a few minutes.

Take a length of lace and insert the ends through the two holes which have been punched at the ends of the buckle end. Make the ends of the lace even. Using one end of the lace, lace to the right across the top edge of the buckle end, using the in-and-out or running stitch. An awl may have

FIG. 126.

to be employed to clear the holes through the strands. With the other end of the lace, lace to the right across the bottom edge of the buckle end. Lace, across the first row of vertical holes, bringing the two ends of the lace together in the middle. Cross the laces and pass each end back through several of the holes. The lacing may be continued back to the starting point if desired. This fills in the spaces and results in a stronger stitch. Cut off the lace and hammer the ends down with a mallet. Take another length of lace and draw it through the middle two holes of the second row of vertical holes. Even the ends. With one end, lace to one edge. With the other end, lace to the other edge. Use the in-and-out stitch. At the edge, pass the lace back through one hole. Cut off the ends of lace and hammer down. Here again, the lace may be returned to the starting point.

If a flat metal keep is used, the stranded ends of the belt may be inserted

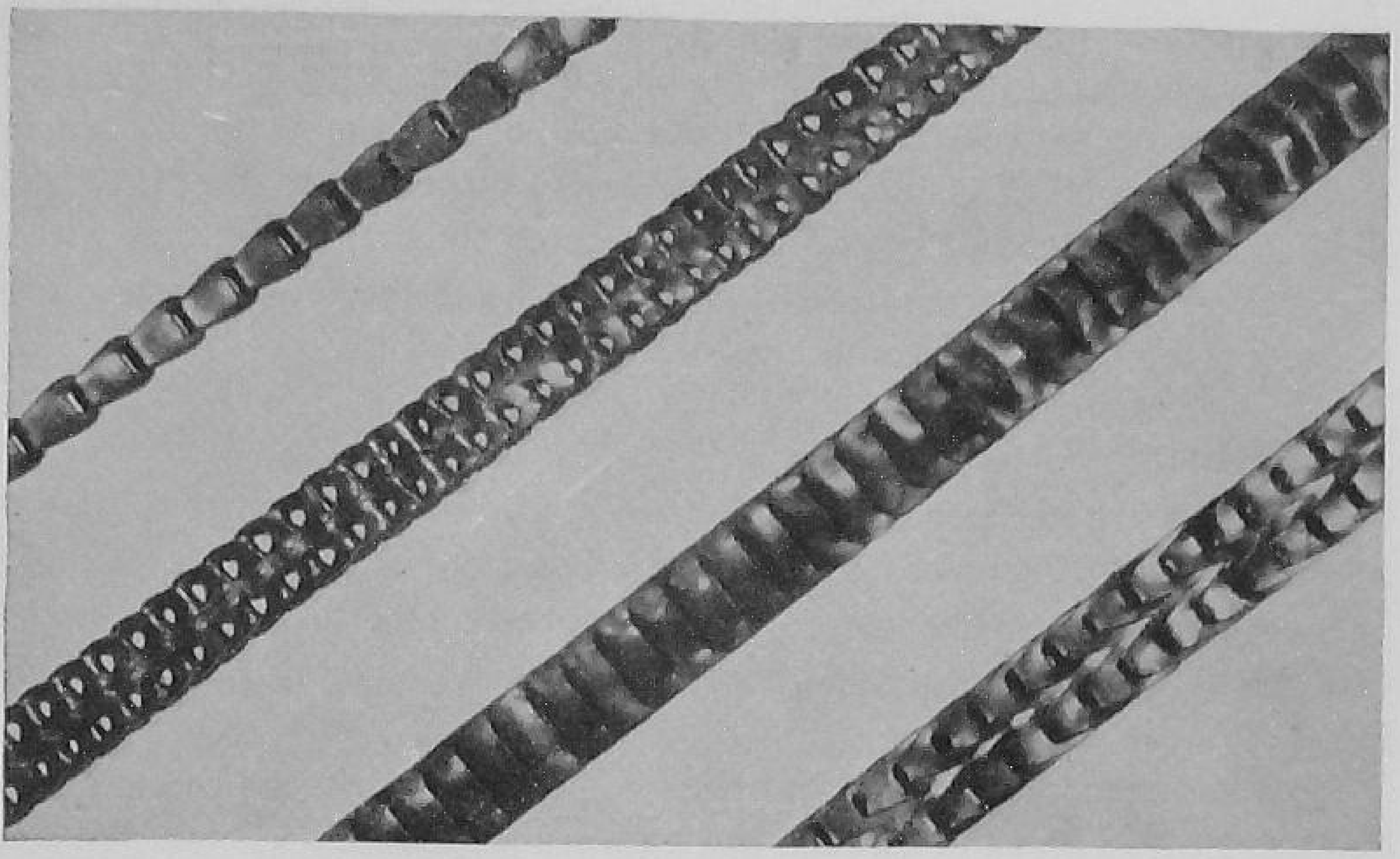


Fig. 127.

into the buckle end until they cover the second row of vertical holes (see Fig. 126). Place the flat metal keep into position and lace as described above.

If a belt does not need a separate buckle end, i.e., plain laced belts,

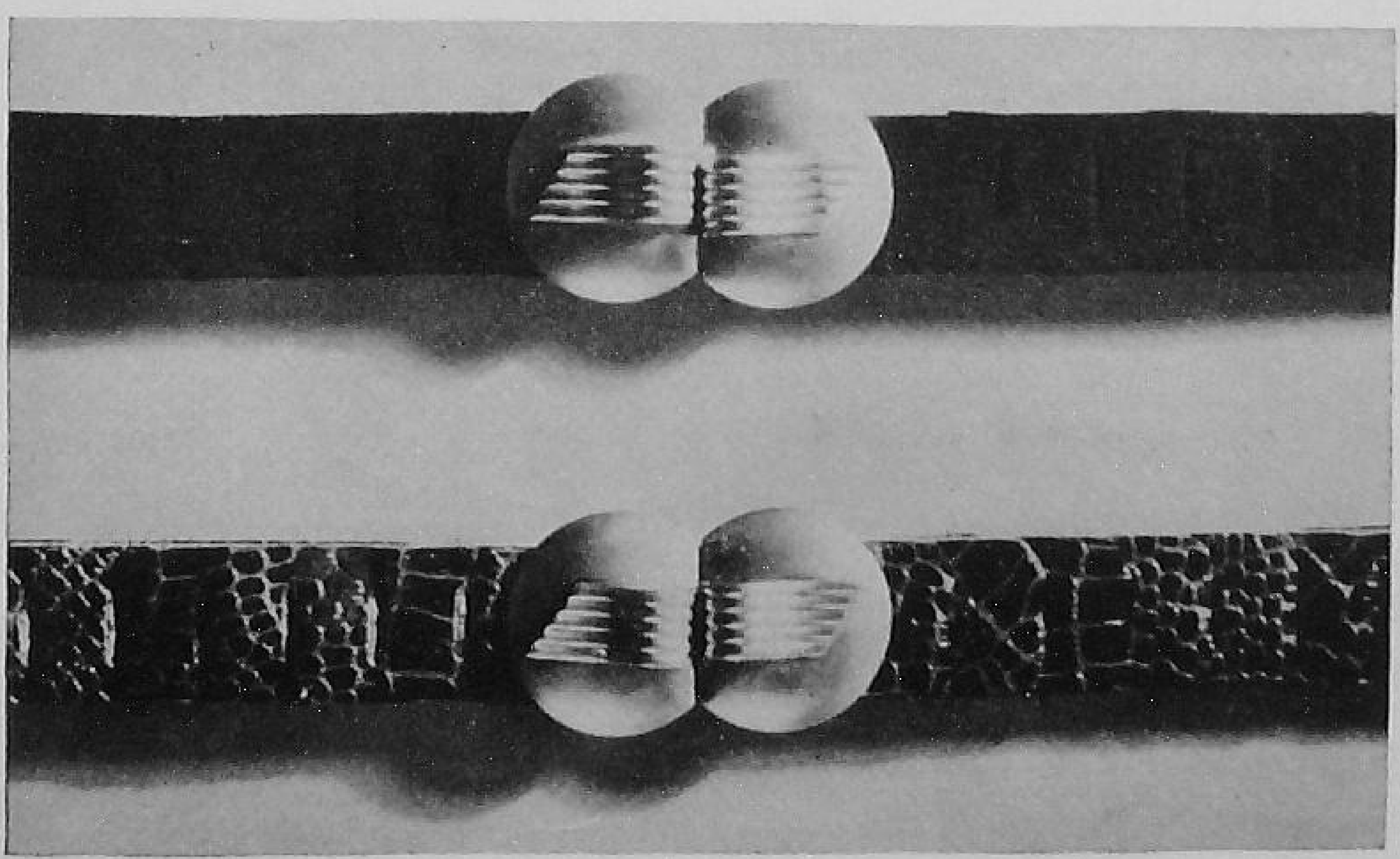


Fig. 127.

carved belts, blind braided belts, etc., the buckle may be attached directly to the buckle end of the belt. The layout may be the same as the layout of the separate buckle end shown at *A*, Fig. 124.

Another method of fastening the buckle is by the use of snap fasteners. Fold the end of the belt back on itself. Fasten the end of the belt with a snap fastener. Again open the end and cut a slot in the fold for the buckle tongue. Mount the buckle and close the snap fastener.

104. Make a link belt.

Link belts are not braided but have an appearance somewhat similar to a braided belt. The links may be cut by hand but it is quite a slow and tedious job. Most leather supply houses furnish link belt sets, complete with buckles, loops, strap ends, and directions for making the belts (see Fig. 127).

Most of the belts are started at the buckle end. Insert the prong of the buckle (see *B*, Fig. 128) through the center slot of the buckle tab and fold the two ends evenly together (see *C*, Fig. 128). Insert keep between the tab ends. Insert a link through the holes in the tab. Fold link (see *C*, Fig. 128). Continue inserting links until the desired length has been reached.

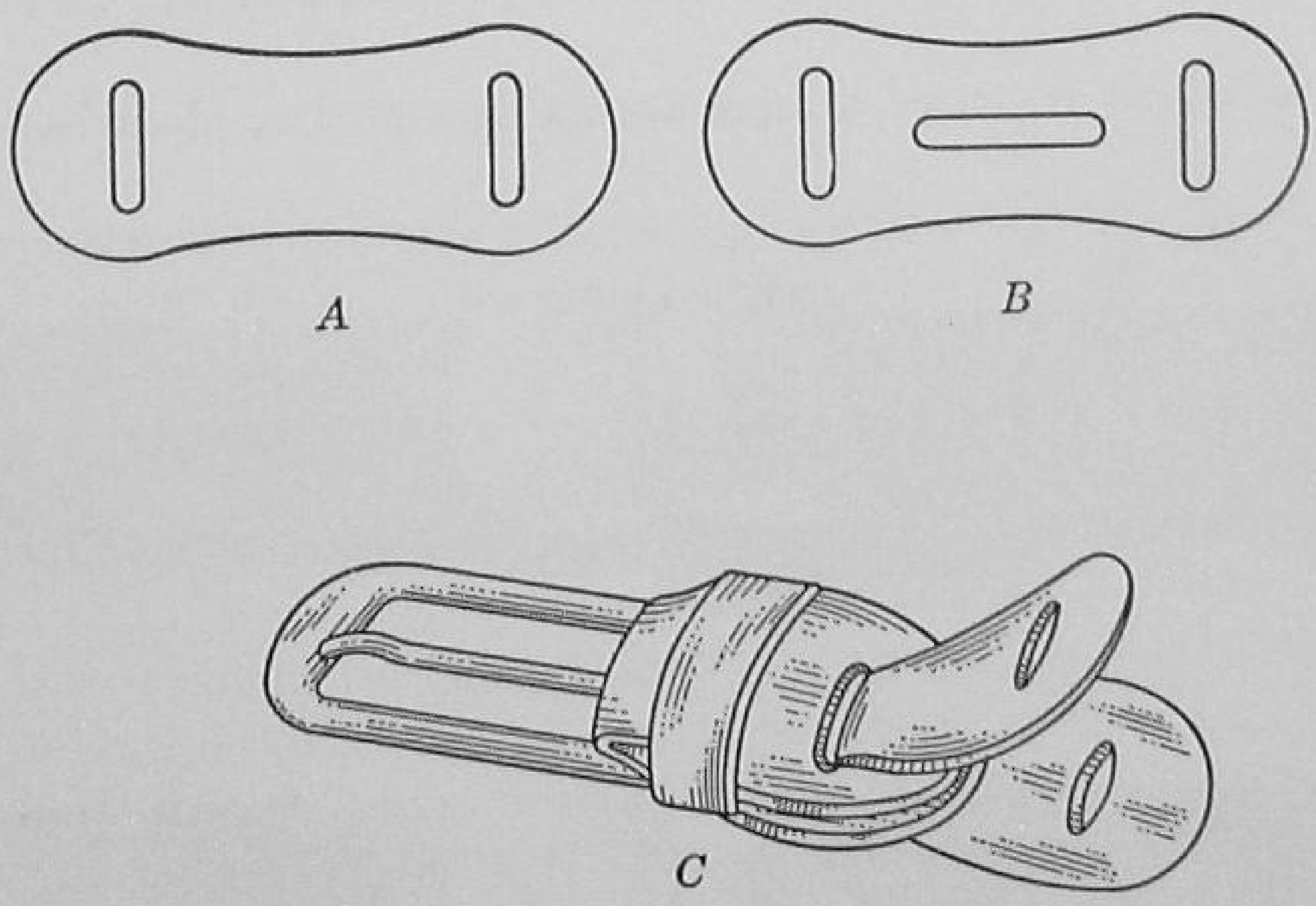


FIG. 128.

Insert the end of the tongue or strap end, which has a snap fastener applied to one end of it through the slots of the last link, and close the fastener. Some link belts are worked from the tongue or strap end to the buckle.

Chapter IX

HOW TO MAKE A BRAIDED LANYARD

Many practical articles can be made by braiding. Whistle lanyards, dog leashes, bracelets, and bag handles are only a few. Materials for braiding can be obtained in many colors. Craft strip (gimp) is a seamless plastic lace which has a bright finish on both sides. It has beveled edges, is avail-

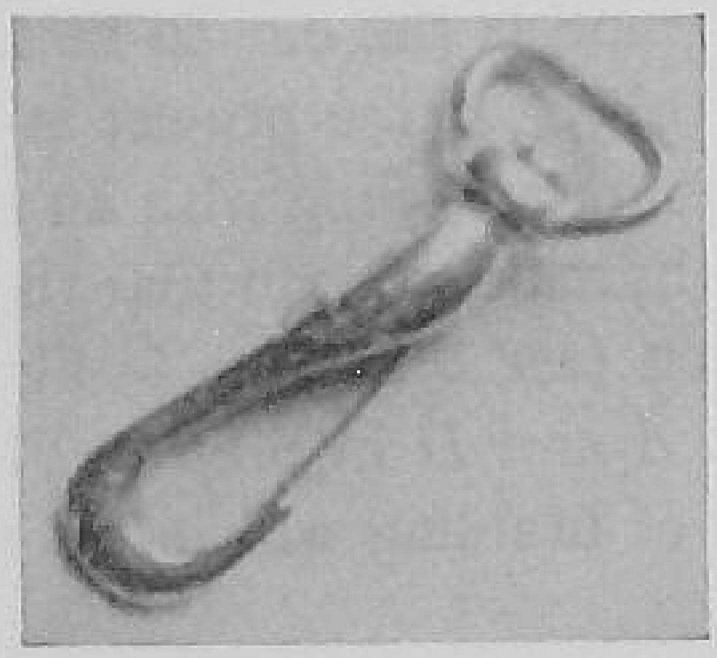
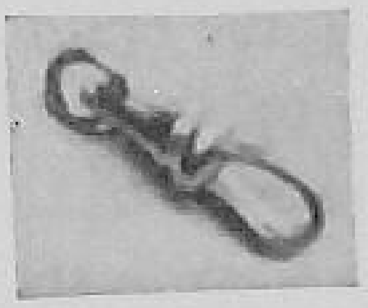



FIG. 129. Swivel snaps.

able in $\frac{3}{32}''$ and $\frac{1}{8}''$ widths, and may be obtained in a wide range of colors. Pyro-Cord is a round coated cord with a bright finish. It is approximately $\frac{1}{16}''$ in diameter and may also be obtained in a variety of colors. Goat skin lacing is also excellent for braiding purposes.

105. *Place two thongs, one black and the other brown, through the ring of a swivel snap* (see Fig. 129).

Pull the thongs through the ring to their middle point and even the ends. Position the thongs as shown in Step 1, Fig. 131. The colors should alternate as shown; *A*, black; *B*, brown; *C*, black; and *D*, brown. Hold *A* and *B* in the left hand and *C* and *D* in the right hand.

106. *Pass* C *over* B *as shown in Step 2, Fig. 131.*

This locks the thongs in place on the ring and brings both strands of black on the left side and both strands of brown on the right. The braiding really commences at this point.

107. Grasp A *and* C *in the left hand and* B *and* D *in the right* (Step 2, Fig. 131).

With the right index finger, push *D* under *B* and *C* and up between *A* and *C* (see Step 3, Fig. 131). With the left index finger, push *D* over *C*. Grasp the two black strands in the left hand and the two browns in the right hand and tighten the weave (see Step 4, Fig. 131).

108. With the left index finger push strand A *(Step 4, Fig. 131) under strands* C *and* D *and up between strands* D *and* B (see Step 5, Fig. 131).

Turn it over strand *D* (Step 6, Fig. 131) and tighten the weave.

109. Finish braiding.

It will be noticed that the highest strand is the one to be next braided (see *A* in Step 4 and *B* in Step 6, Fig. 131). If the project is not finished at one sitting, the braids may be held from unraveling with an elastic band. When taking up the braid after leaving it, make certain that there is a high strand on one side of the braided portion (see *B* in Step 6, Fig. 131), and that the two middle strands cross (see *A* and *D* in Step 6, Fig. 131). It will be noticed that a diamond pattern of braiding will result (see Step 7, Fig. 131).

110. Braid a lanyard with a spiral pattern (optional).

If the thongs or strands are placed through the swivel loop and positioned as shown in Step 1_1, Fig. 131, instead of positioning them as shown in Step 1, Fig. 131, a spiral design will result. The method of braiding is exactly the same as for the braided diamond design. Follow Steps 1_1 through Step 6_1, Fig. 131. Step 7_1 shows a portion of completed spiral braiding.

111. Make a square crown or crown terminal on the end of the lanyard.

Turn the braided end upside down and hold the end tightly between thumb and fingers. Spread the four strands apart as shown in Fig. 130.

Weave the four strands together as shown in Fig. 132 and tighten the weave as shown in Fig. 133. Continue weaving the square crown until it is several inches in length.

112. Finish end of crown.

One method of finishing the crown is to tuck the ends back under and through the previous weave. Pull taut and trim the ends. The other

method of finishing the crown is with a terminal Turk's-head. Weave each end as shown in Fig. 134. When all ends extend up through the middle, pull them up tight and trim ends to desired length (see completed Turk's-head on the two lanyards shown in Fig. 135).

113. Make a spiral crown (optional).

A spiral crown is shown on the knife Lanyard in Fig. 135.

Start the spiral crown the same as the square crown. Each succeeding crown is rotated 45 degrees. This is done by bending the ends diagonally across the square beginning, and weaving and tightening them in a similar manner as done in weaving and tightening the square. Finish the crown as described in Step 112.

114. Make a sliding crown.

The crown may be woven around the swivel snap end of the lanyard to allow for length adjustment.

Start the square crown as shown in Fig. 132. Before tightening the weave, insert the swivel snap end of the lanyard up through the middle of the square weave. Tighten the weave.

Continue weaving the crown as shown in Fig. 135. Finish crown with a Turk's-head.

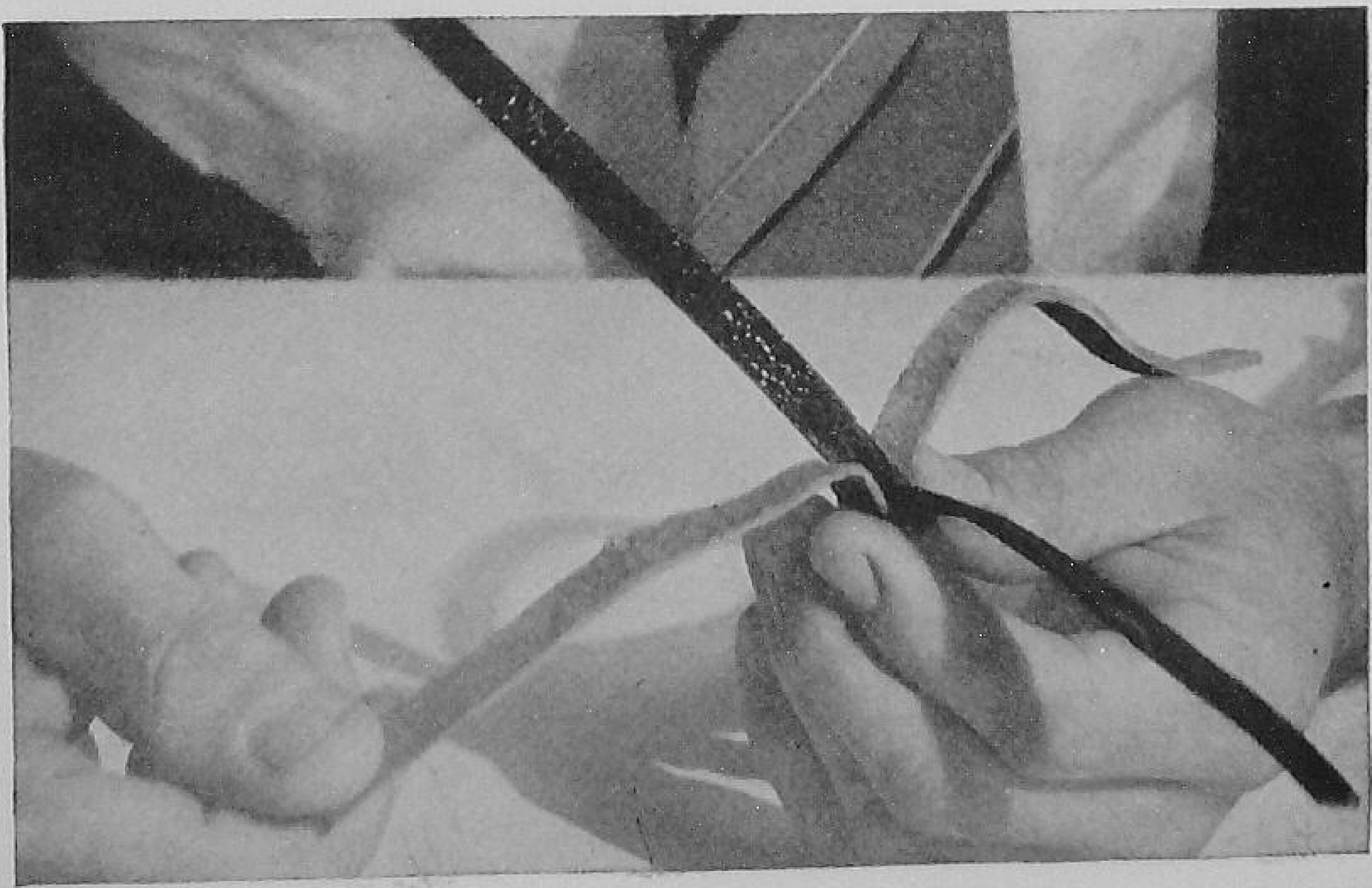


FIG. 130.

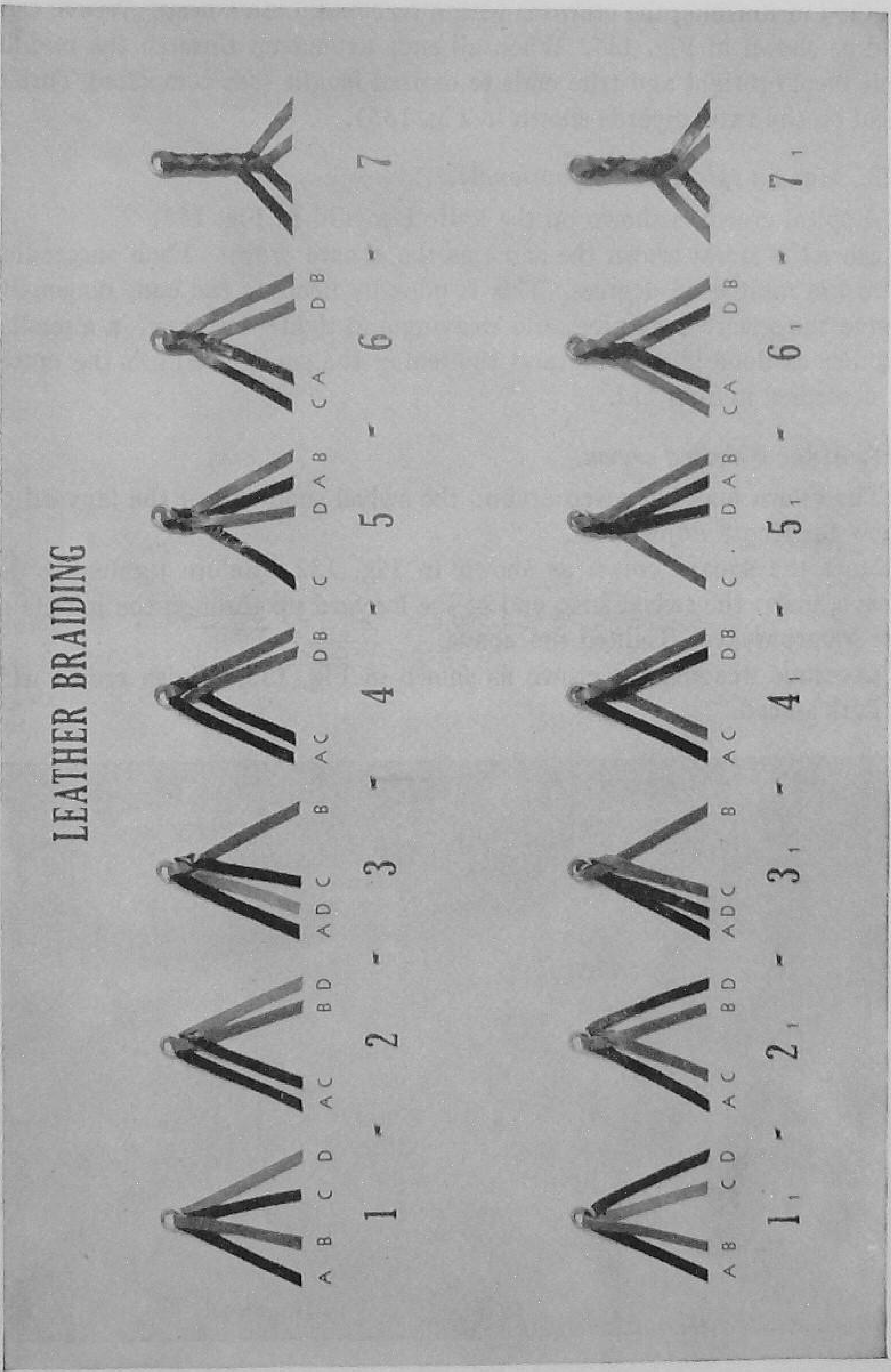


FIG. 131.

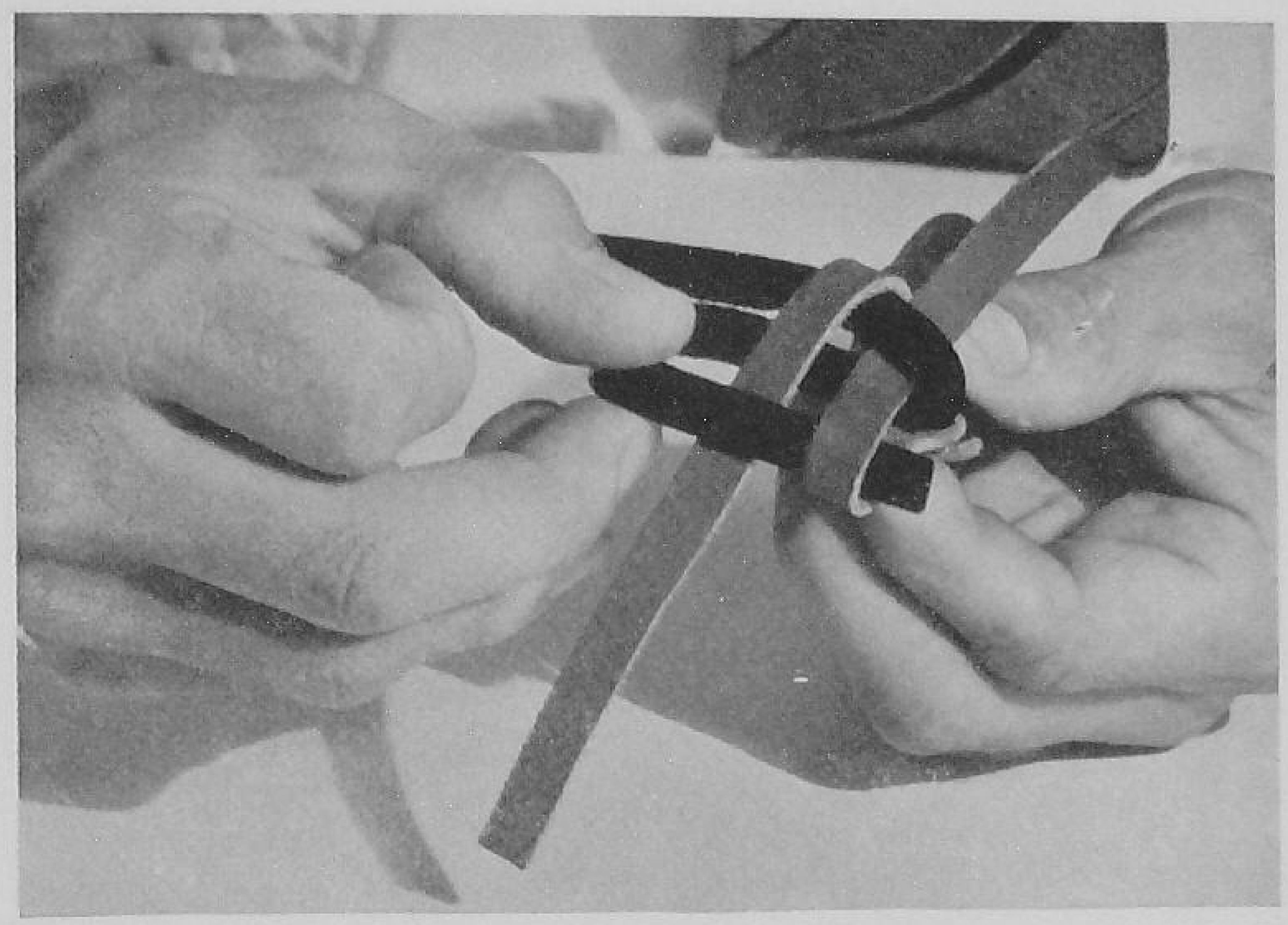


Fig. 132.

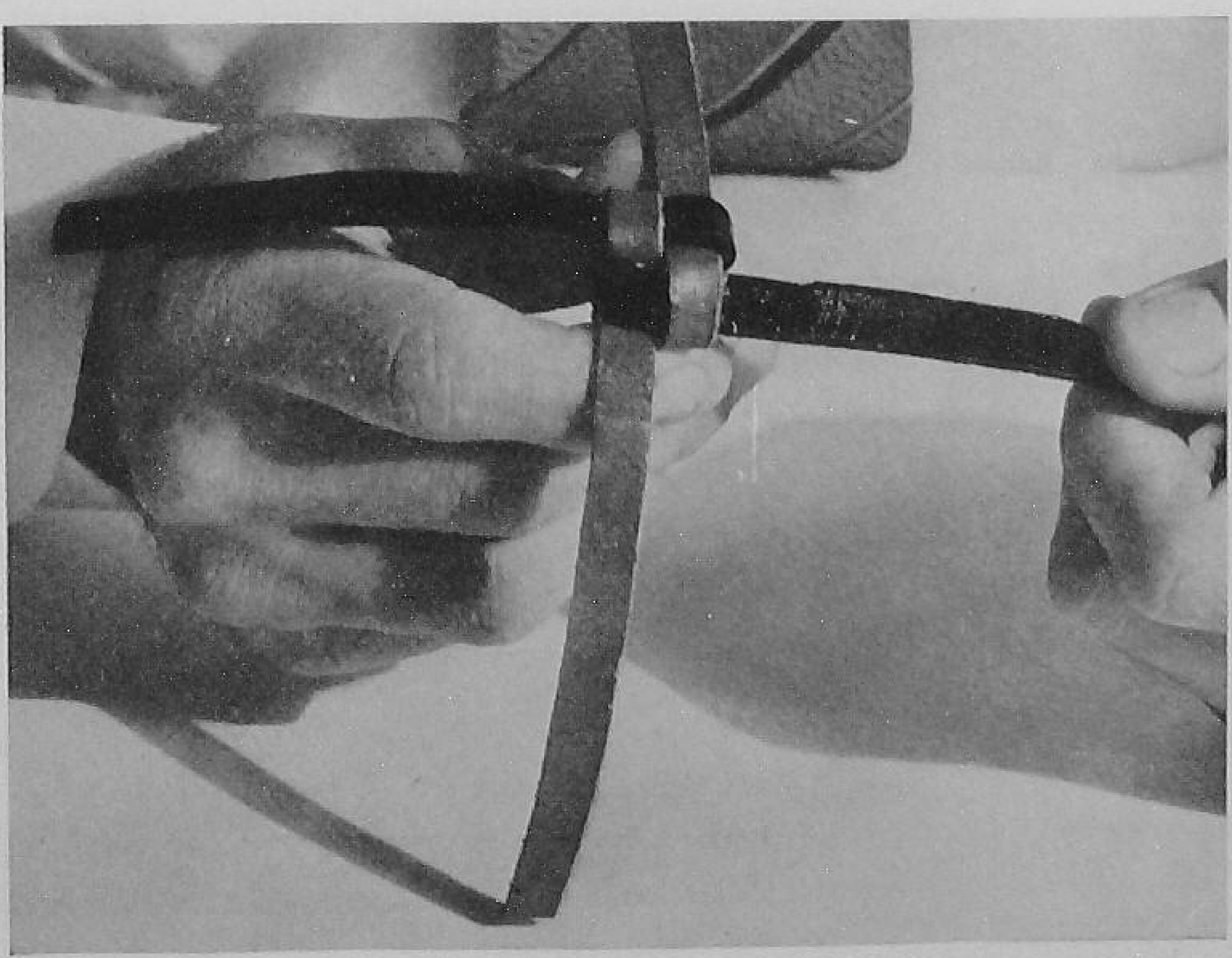


Fig. 133.

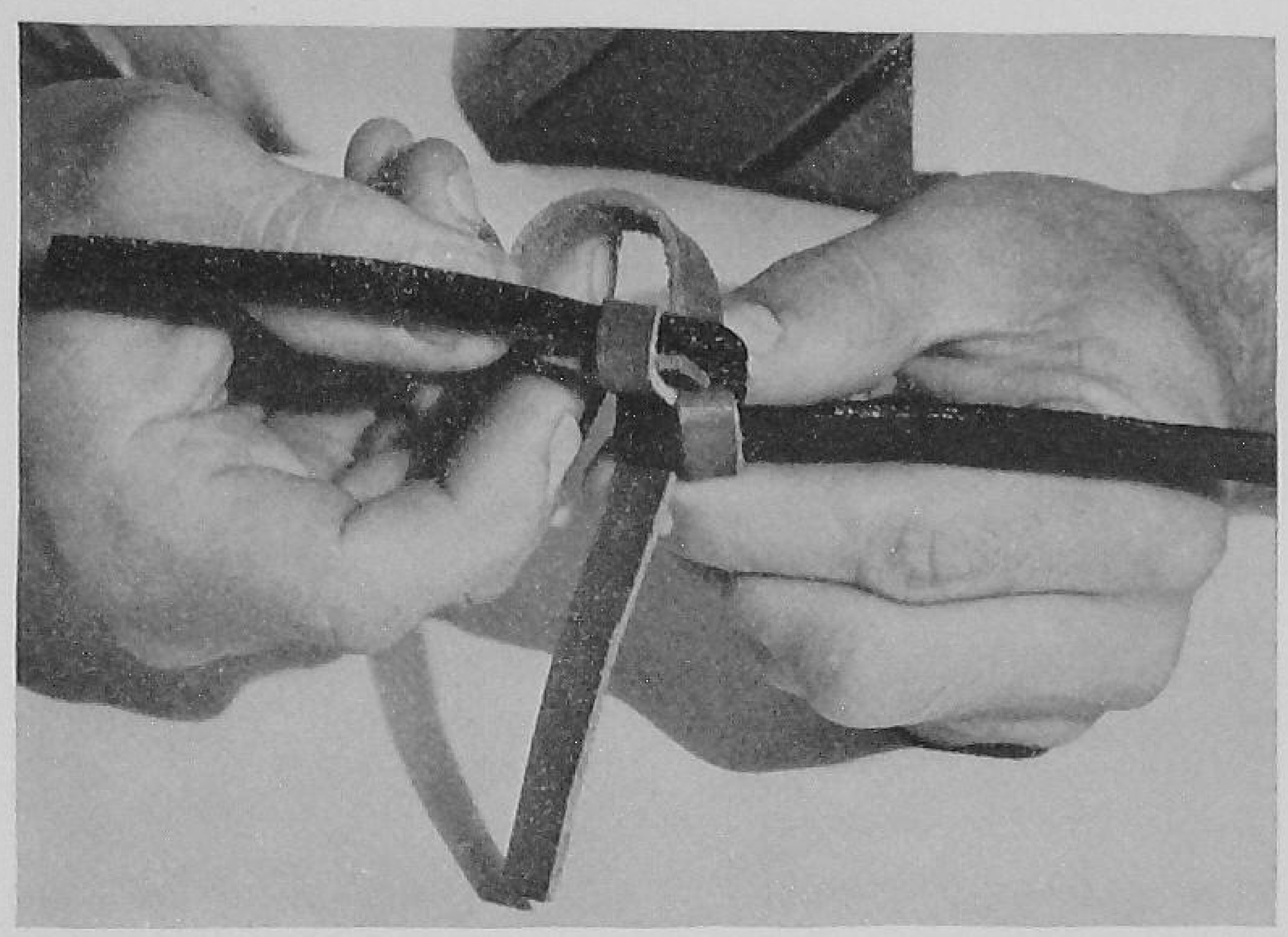


FIG. 134.

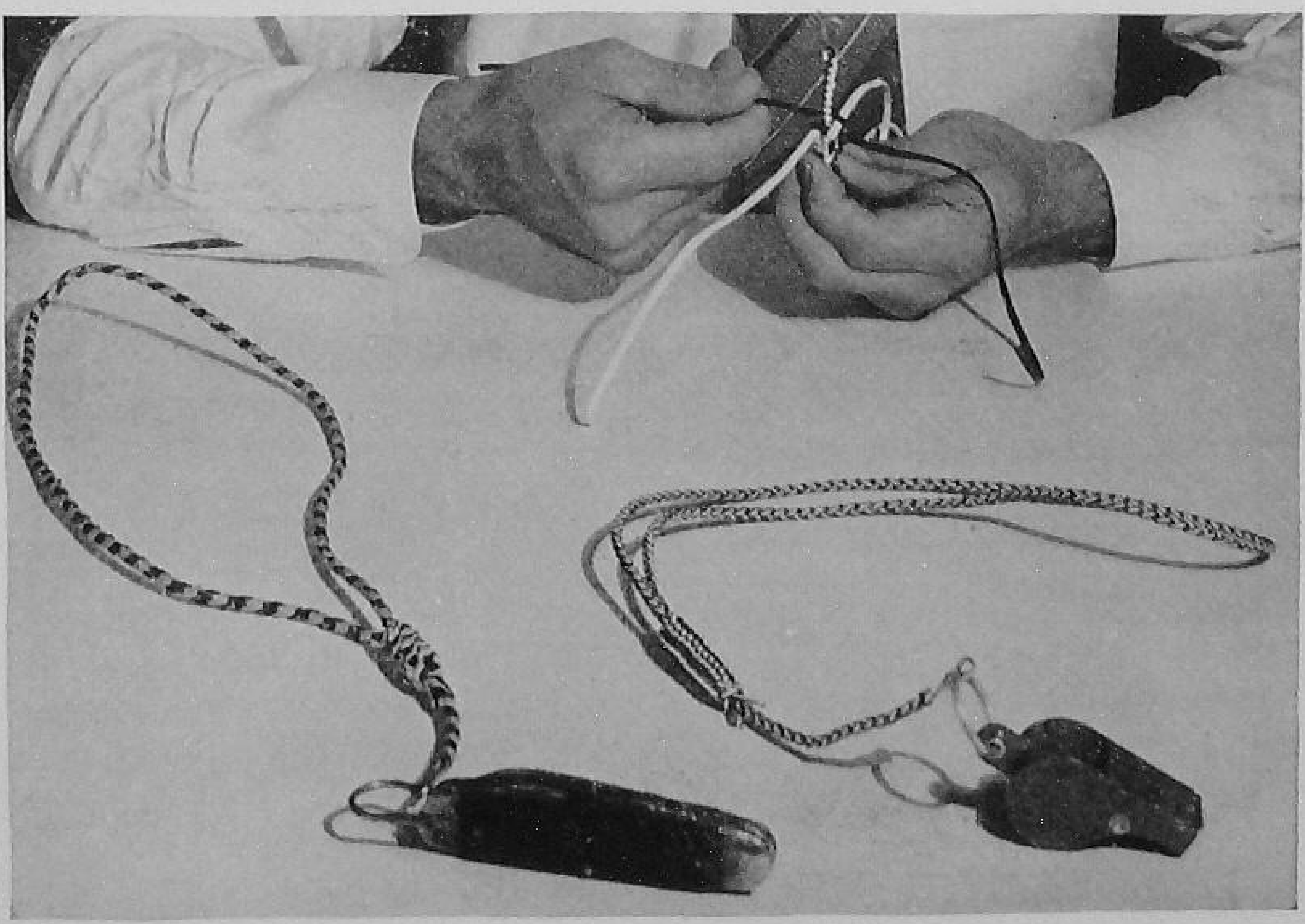


FIG. 135.

Chapter X

A FEW HINTS TO THE LEATHERCRAFTSMAN

115. Care of leather tools.

Leather tools should be kept rust free. Although they are nickel or chromium plated, some tools have a tendency to rust. When storing tools for any length of time, always cover them with a fine film of oil or other rust preventive. Leather tools may be cleaned with fine steel wool and polished on a buffer.

116. Project or methods boards.

If one expects to teach leatherwork in summer camps or schools, various project boards showing the step-by-step procedure in constructing a certain project are very helpful. Project boards are similar to an instruction sheet and are usually made by the instructor. The project board should be practically a self-teaching unit. Various examples of these boards are shown in Figs. 136, 137 and Fig. 130, Chapter IX.

The purpose of these boards is to save the teacher or counselor a great deal of verbal repetition. The time saved may be used for individual instruction and group demonstrations. Needless to say, the project board should depict the making of basic, or the most popular, projects.

117. Ordering and storing leather.

Leather is purchased in quarter, half, or whole skins and is furnished in the natural irregular shape. Cowhides, steer hides, and elk are available in sides. A side is treated as a whole skin and is sold by the whole side, half side, or quarter side. When ordering leather, state the number of square feet desired, basing the figure within the range of sizes quoted by the supply house for the particular kind of leather. Multiply the number of square feet by the square foot price for the kind of leather desired.

The leather will be delivered rolled and wrapped. DO NOT FOLD LEATHER SKINS FOR STORAGE. If the skin is too large for storage

cut the skin into halves or quarters. To divide a skin in half it is cut down the center from neck to butt. A quarter skin is made by cutting a half skin in the center from back to belly. Roll the pieces and cover them with wrapping paper for storage. Be sure the skin is rolled with the grain side out. This will prevent wrinkles. Store the leather in a cool, dry place.

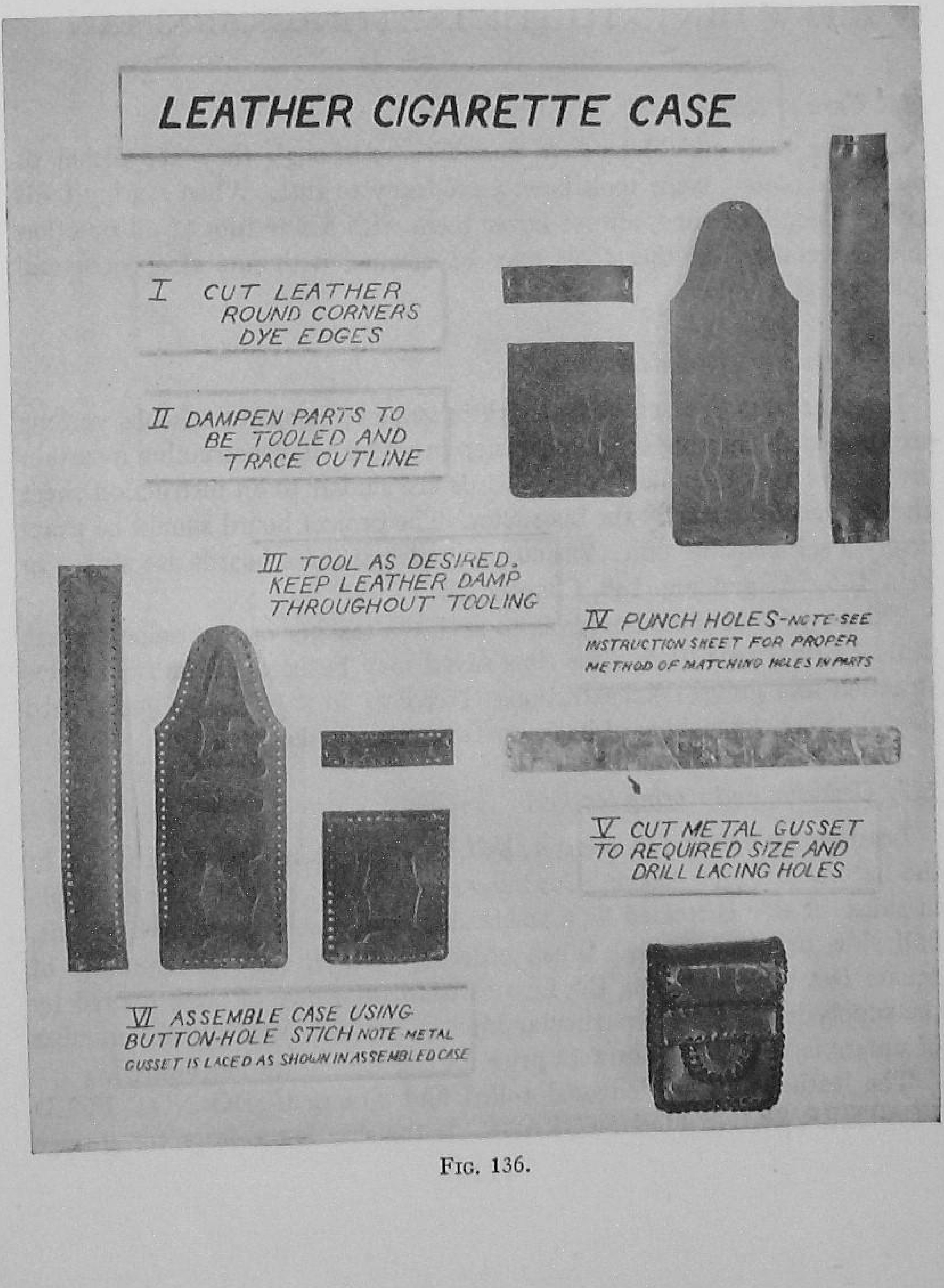


FIG. 136.

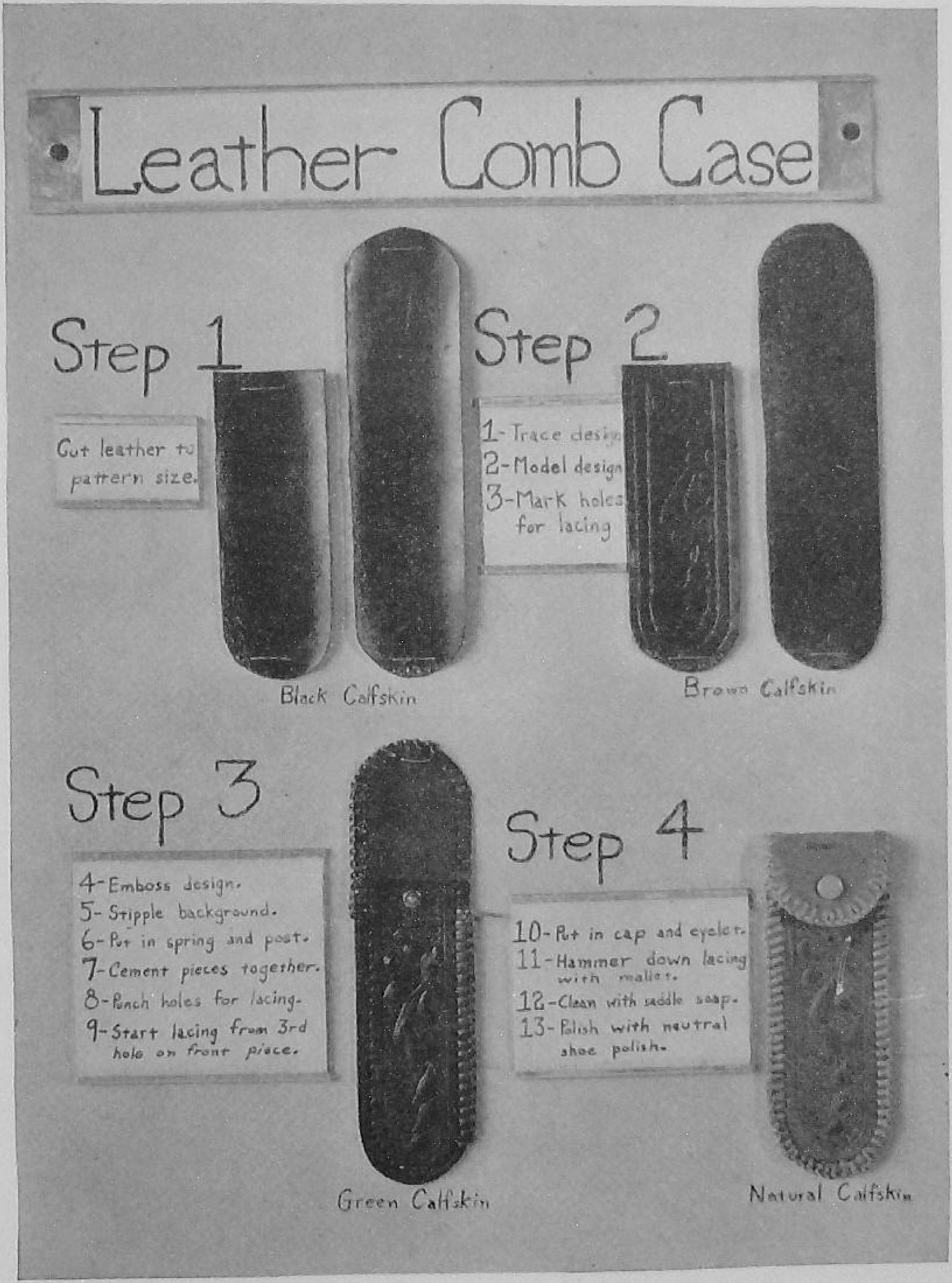

Leather Comb Case
Step 1
Cut leather to pattern size.
Black Calfskin
Step 2
1-Trace design
2-Model design
3-Mark holes for lacing
Brown Calfskin
Step 3
4-Emboss design.
5-Stipple background.
6-Put in spring and post.
7-Cement pieces together.
8-Punch holes for lacing.
9-Start lacing from 3rd hole on front piece.
Green Calfskin
Step 4
10-Put in cap and eyelet.
11-Hammer down lacing with mallet.
12-Clean with saddle soap.
13-Polish with neutral shoe polish.
Natural Calfskin

FIG. 137.

Woodworking Crafts Section

BY

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New York University

INTRODUCTION TO WOODWORKING CRAFTS SECTION

This section presents handicraft material concisely in one volume to appeal to those people who want to begin working with wood by exploring various phases of the art. The reader can choose whittling, coping saw work, inlaying and veneering, wood carving, elementary joinery, or wood turning and find the information in this book that will allow him to gain proficiency. With the exception of the chapter on Wood Turning, only hand tools and handtool operations are discussed. A series of basic projects is presented to give the handicraft worker an opportunity to become acquainted with the minimum number of tools and operations. Whittling is discussed first because a considerable amount of experience in working with wood can be gained with the smallest number of tools and a minimum of material.

The making of a simple basic project is described in each chapter. Only a minimum amount of information regarding the tools and materials is given at the time the tool or material is to be used in order not to obscure the final objective.

Projects are grouped to provide a challenge for the more skilled handicrafter. Provision is also made for some choice of a particular project in each group. This feature will appeal to the teacher of industrial arts or crafts work because a variety of projects may be carried on in the same class at the same time, thus accommodating the individual interests of students. As each successive group of projects is reached only the new operations, tools and materials are described; repetition is thereby minimized. It is suggested that the beginner start with one of the basic projects in the first group and progress through each group to obtain the best continuity of instruction. This procedure should not, however, prevent the handicrafter from choosing a more difficult project if he likes because he can easily refer to instructions previously given. All of the projects described in this book have been made in the author's woodworking and handicraft classes.

II. WOODWORKING CRAFTS SECTION

•

Chapter I
WHITTLING

•

Chapter II
COPING SAW WORK

•

Chapter III
SQUARING STOCK AND ELEMENTARY JOINERY

•

Chapter IV
INLAYING AND VENEERING

•

Chapter V
WOOD CARVING

Chapter I

WHITTLING

Whittling is discussed first because it provides the handicrafter with an opportunity to test his interests and ability in working with wood, using the least amount of equipment. This handicraft is exceptionally well suited for campcraft work and occupational therapy. The whittler may work at his leisure, producing interesting objects, without spending large sums of money for equipment. Also, small pieces of wood may be used, avoiding further expense.

Woods to Use

White Pine. Probably white pine is the most suitable wood for the beginner. It is soft, close grained, and can be obtained free from knots. A sharp knife will cut across the grain almost as easily and smoothly as with the grain.

White pine varies in color from cream to light reddish brown in the heartwood, and from pale yellow to white in the sapwood. These variations in color make for a variation in finish to suit almost anyone's ideas.

Red Cedar. Cedar is quite soft and cuts well with a knife. Like pine, it should be easily obtainable for most handicrafters. It is attractive because of its agreeable color which runs from light red-brown to purplish red in the heartwood and from rich cream to white in the sapwood. The variations in color in a single piece being whittled will produce interesting and striking contrasts in the finished job.

This wood contains numerous knots and for this reason the blank must be carefully selected before beginning the whittling; a knot is practically impossible to cut with the knife and will cause the whittler much distress.

Basswood. The sapwood is cream in color, running to a light brown in the heartwood. The grain is straight and close, making it easy to work. This wood should be easy to obtain.

Whitewood or Yellow Poplar. The heartwood is light greenish, or yellow-brown, with occasional streaks of purple and even black. This

variation produces interesting contrasts and the wood is close grain and easy to work, although it is a bit more difficult to cut than pine.

Poplar takes almost any kind of paint or stain, and finishes nicely.

Red Gum. The heartwood of red gum is reddish brown in color, and has a smooth and uniform texture. It is harder than poplar, but it, too, takes a nice finish either with stain or natural.

Mahogany. There are many kinds of mahogany, usually designated by the place from which it comes, such as Honduras, West Indies, Mexico, etc. The different mahoganies vary considerably in texture and degree of hardness, but all mahoganies are well adapted to whittling. It is usually red-brown in color, but in varying shades.

Cherry. The color varies from light to dark reddish brown. This wood is more difficult to work but it takes clear, sharp cuts and resists wear. It, too, takes a nice finish, either stained or natural.

Black Walnut. This is more difficult to work but it is nicely figured and takes a beautiful finish. The heartwood is chocolate brown color with the sapwood running to a cream color.

Maple. There are many species of maple grown in the United States. Sugar maple is probably the most abundant. The heartwood is light reddish brown, running to white sapwood. The wood is very hard and more difficult to work, but it produces nice results where fine clear-cut lines are desired.

This should be a sufficient explanation of the woods rather easy to obtain which are adapted to whittling. The beginner in whittling should select one of the softer woods described for the first several projects in order to get the feel of using the knife. It will depend, largely, on the individual's ability to obtain the woods as to which varieties he will use.

Projects

Group I—Flat Work

The basic tool for the whittler is a pocketknife. Almost everyone has used a pocketknife at some time, either for cutting a piece of string, paring an apple, or sharpening a pencil. Paring an apple or sharpening a pencil is a form of whittling. With a little practice and some instruction, the whittler can soon become adept at whittling pieces of wood into attractive and useful articles.

The type of knife used may be a matter of choice with the individual.

A pocketknife having one or more blades may be used, although some whittlers prefer a solid-handle knife, such as the Sloyd knife (Fig. 1*B*) especially for the heavier roughing out process. It is suggested that a good three-bladed knife be purchased as the different shaped blades are desirable for different cuts.

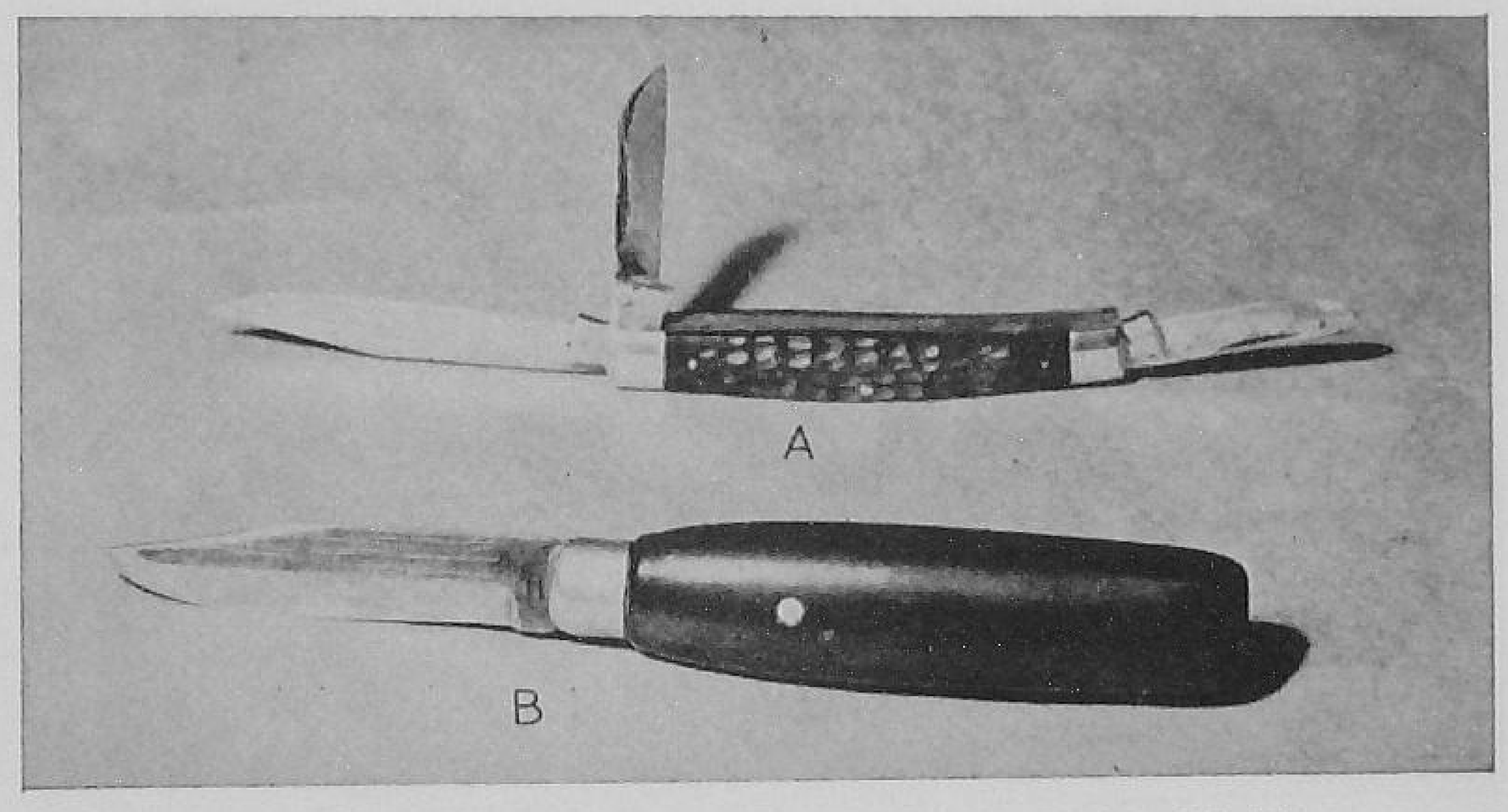


FIG. 1. Knives for whittling. (A. Pocketknife. B. Sloyd knife).

It is extremely important that the knife be very sharp. Before starting to whittle, the handicrafter should learn to sharpen the knife—and it must be kept sharp during the whittling process. The sharpening is done on an oilstone or on a whetstone. It is suggested that if an oilstone is used, the type which is coarse on one side and fine on the other may be most satisfactory. Hold the knife blade flat on the stone, then raise the back of the

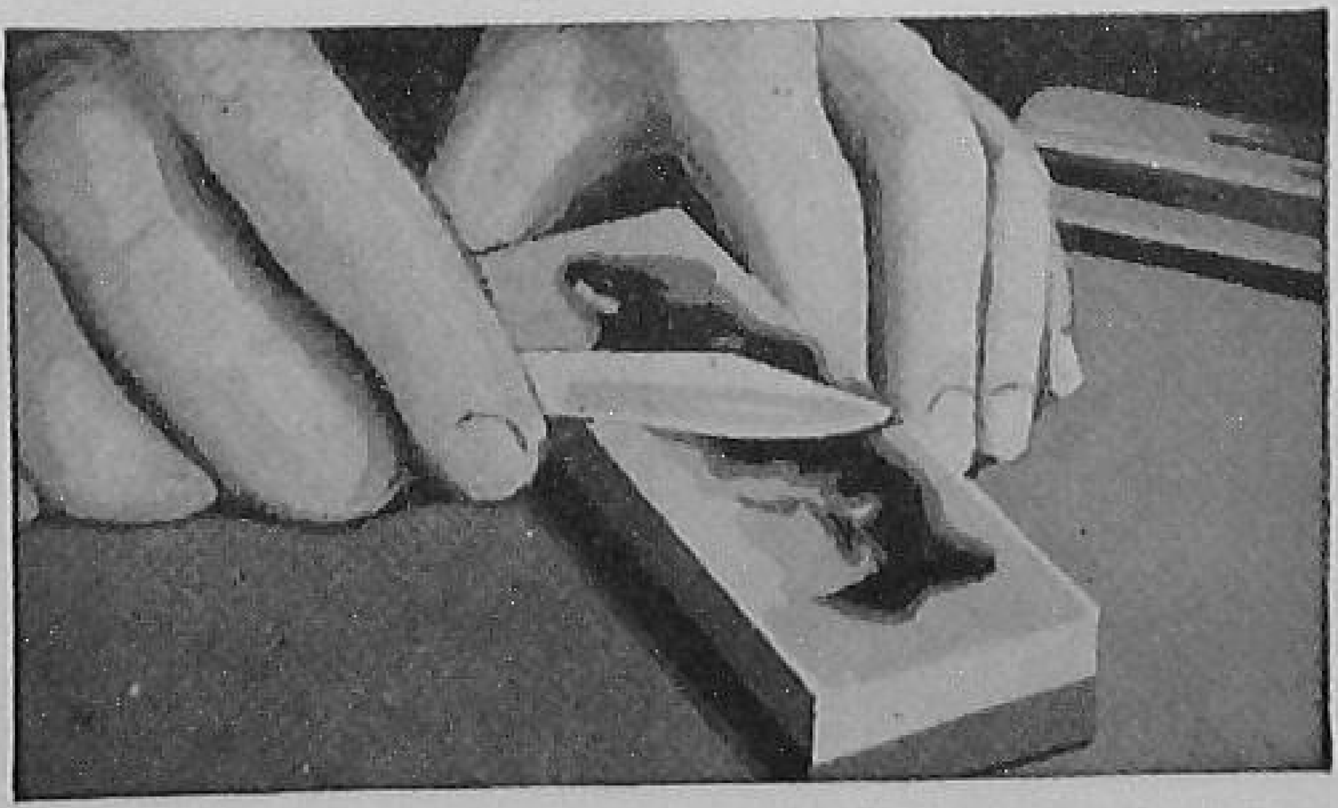


FIG. 2. Sharpening a knife on a whetstone.

blade very slightly. In this position, draw the knife back and forth first on one side then on the other until the edge is sharp. Stropping on a piece of leather will remove any wire edge remaining from the whittling.

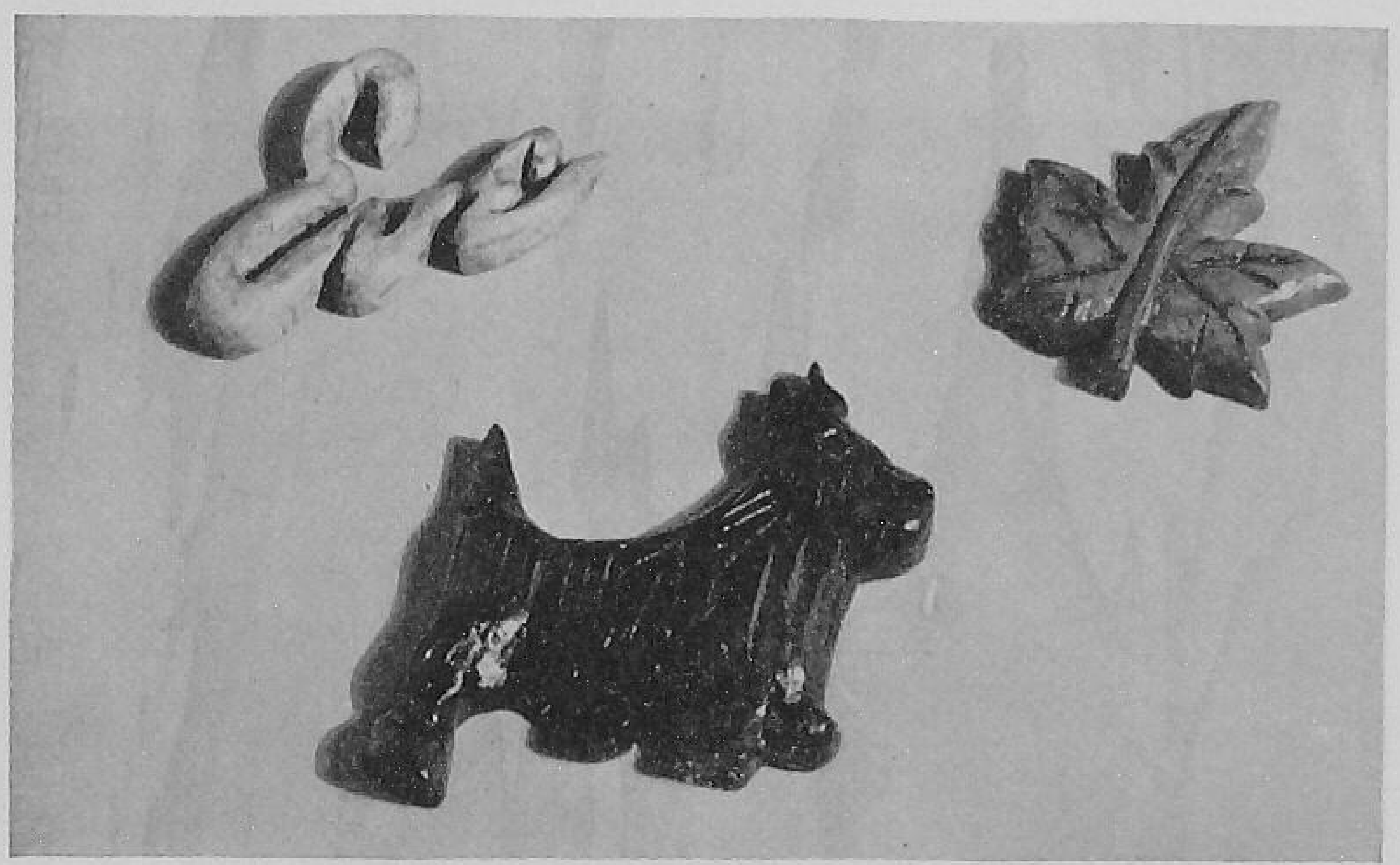


Fig. 3. Whittled decorative pins.

The Decorative Pin—Leaf Design

The making of the leaf design pin will be explained and the other pictures are suggested designs which are made in the same manner.

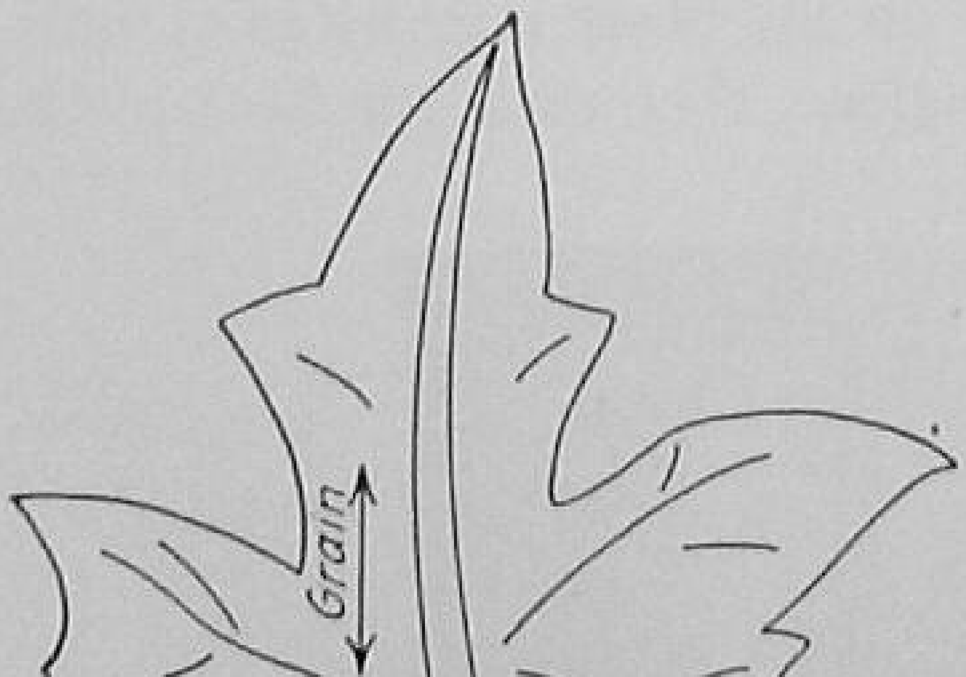


Fig. 4. Pattern for leaf pin.

Fig. 5. The design transferred to the wood.

1. Obtain a piece of wood of the kind described in the beginning of this chapter. The wood should be ¼″ or ⅜″ thick and large enough to trace the full-size pattern on one surface, approximately 2″ x 2½″. Using a piece of carbon paper trace the design shown in Fig. 4 directly on the piece of wood as shown in Fig. 5.

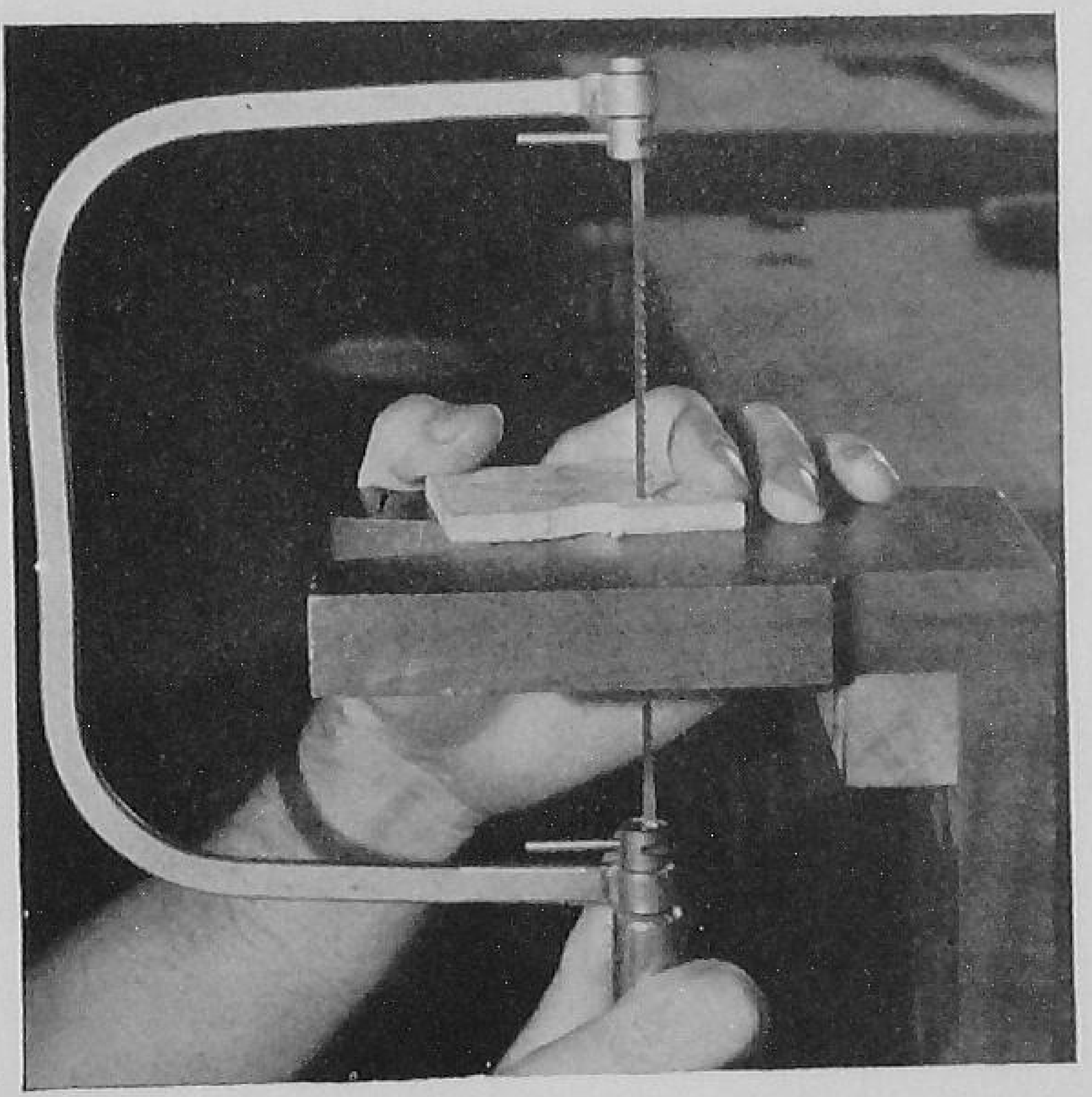


FIG. 6. Using the coping saw.

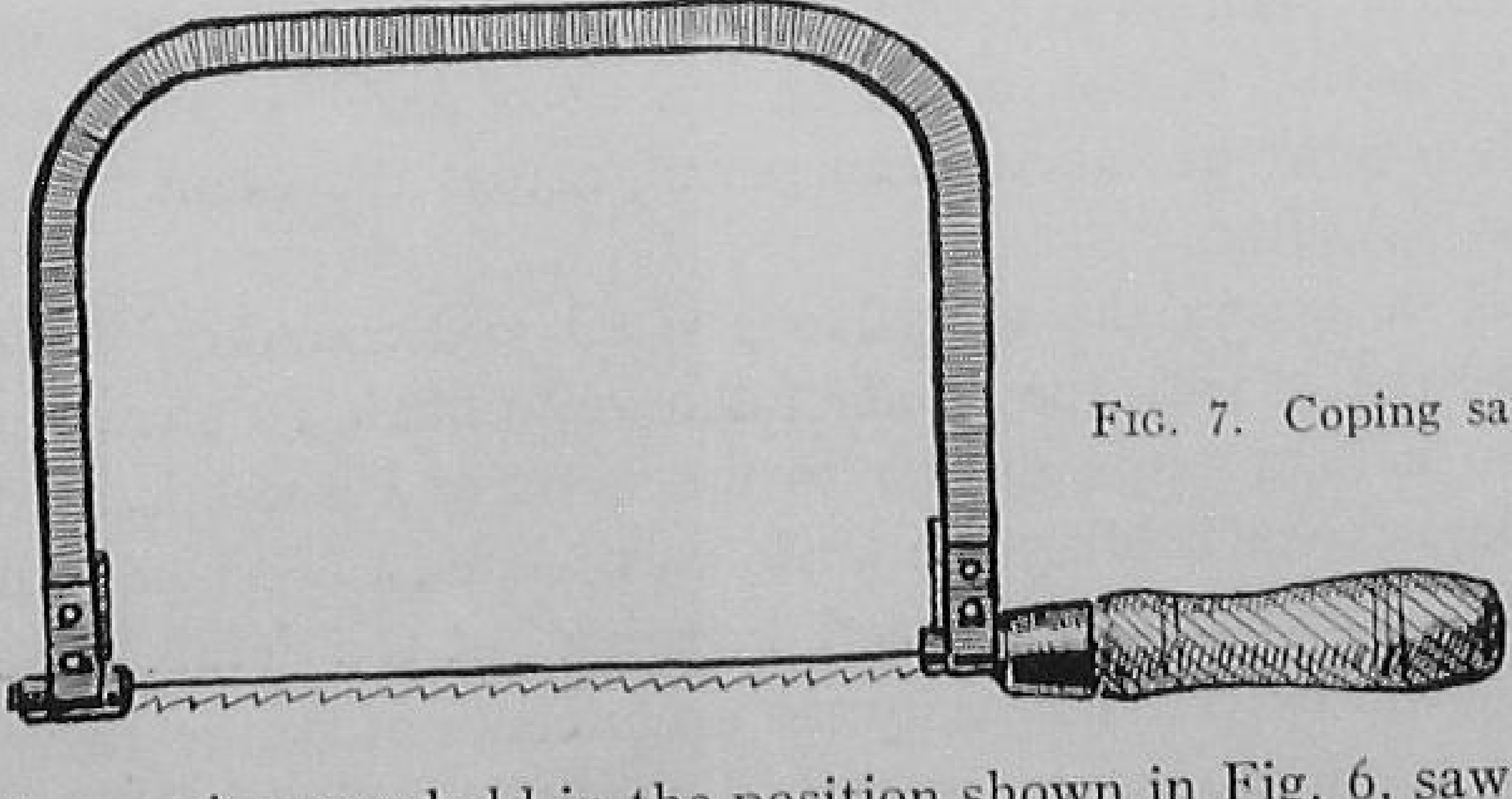


FIG. 7. Coping saw.

2. With a coping saw held in the position shown in Fig. 6, saw just outside the lines of the design. Coping saw frames may be purchased in several styles and sizes, the most common type being shown in Fig. 7.

This type of frame holds the pin-end type of blade. Blades for this type frame are 6½ inches long and have 15 teeth per inch.

3. The edges are now rounded off by whittling as shown in Fig. 8. It is necessary to watch the direction of the grain in the wood and change the grip of the hand on the knife and the direction of the cut in order to conform to the direction of grain. The knife is held firmly in the hand with the thumb on the back of the blade guiding the amount of pressure. The knife is pushed away from the whittler in this type of cut.

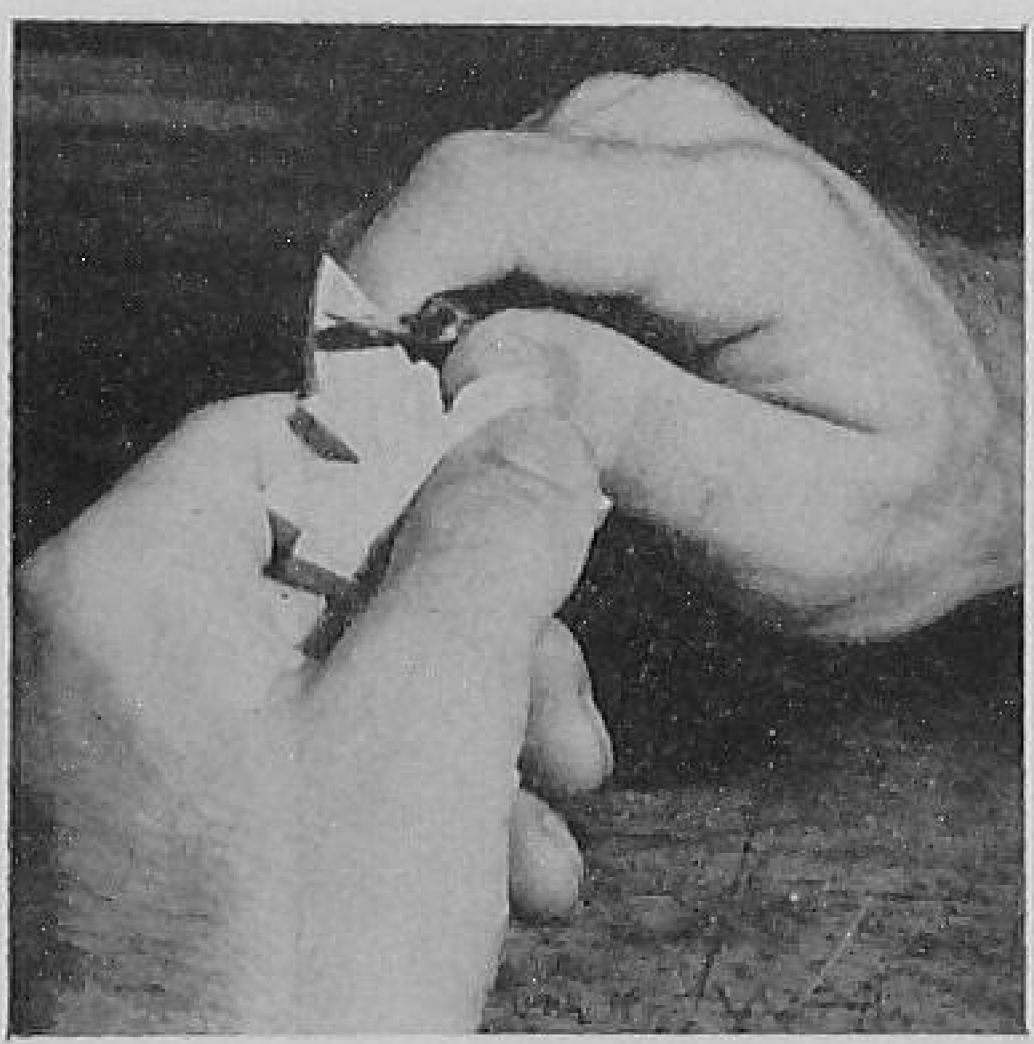


Fig. 8. Rounding off the rough edges, cutting away from the body.

Fig. 9. Cutting toward the thumb.

When cutting into smaller areas it may be necessary to hold the blank of wood in the position as shown in Fig. 9 and pare the wood toward you. Note the position of the thumb on the wood and the grip taken on the knife. Care must be taken when paring across the grain to prevent the wood from splitting.

4. After removing the superfluous wood and rounding the edges, the details are cut in with the point of the knife blade as shown in Fig. 10. The blade is held perpendicular to the wood and a cut is made directly on the line. Then holding the knife on a slant, a V-shaped cut is made which will remove a chip of wood, bringing out the detail. The depth of these lines will be determined by the prominence of the detail desired.

5. The entire job is now smoothed carefully with No. 4/0 sandpaper: sandpapering must be done lightly so that none of the detail is removed.

6. The pin is now fastened on the back of the whittled piece by the use of two small nails shown in Fig. 11. These pins may be obtained from suppliers of handicraft materials.

7. The manner of finishing is largely left to the whittler's desire, and must depend somewhat on the kind of wood used. The wood may be left in a natural finish. In this case the leaf pin should be given two coats of white shellac. If shellac is too thick as it comes from the can, thin with wood alcohol. Clean the shellac brushes with alcohol. After each coat,

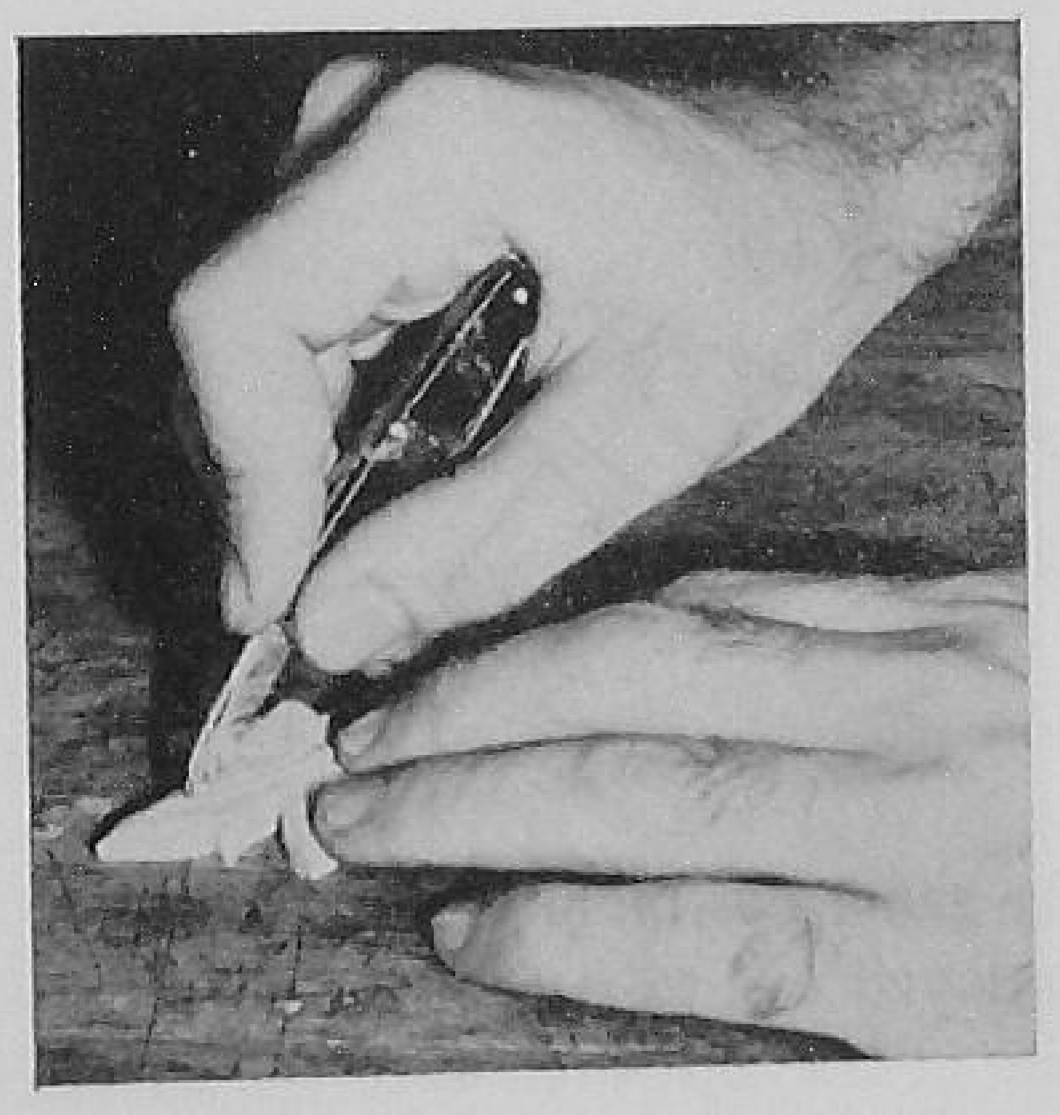


FIG. 10. Cutting in detail lines.

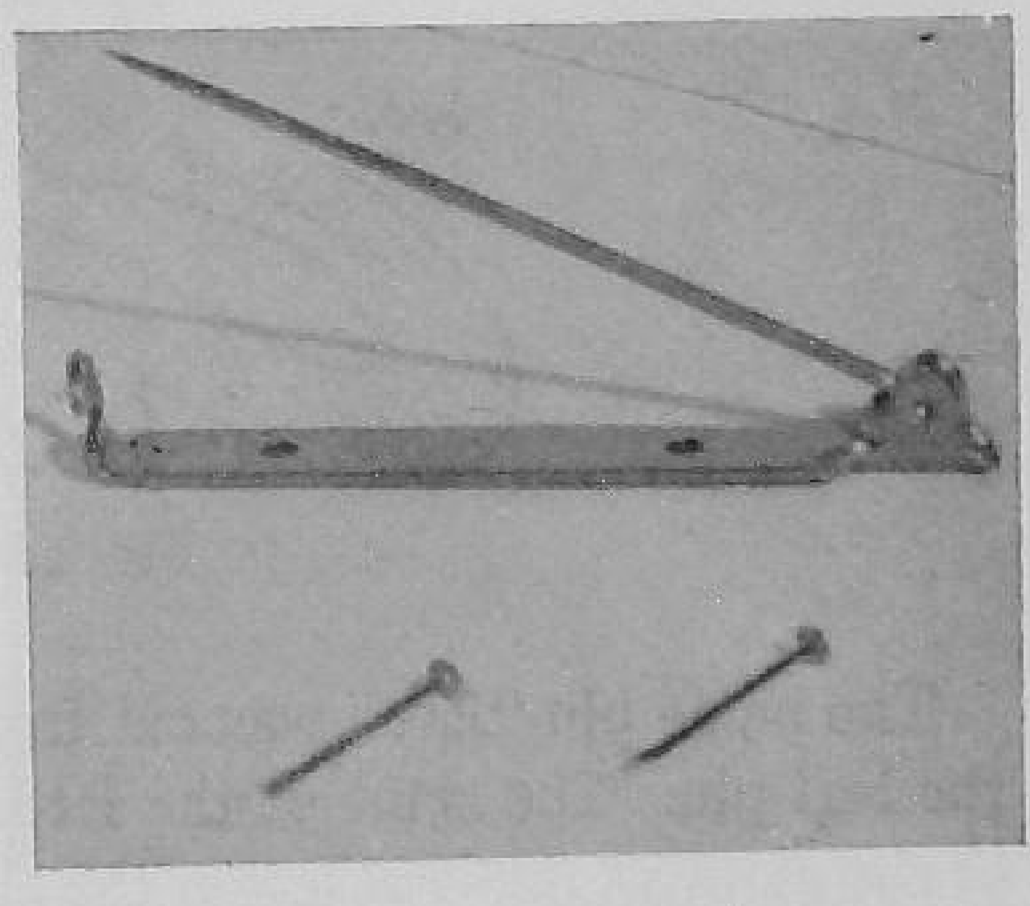


FIG. 11. A pin back.

rub lightly with fine steel wool, taking care to dust off all particles of the steel wool that might be left in the detail lines. Apply a coat of wax and rub briskly to give a nice soft finish. Some whittlers may prefer to stain the wood with a mahogany or walnut oil stain before the shellacing process. Clean stain brushes with turpentine.

The leaf design shown in the illustration was made of white pine and a pleasing effect was accomplished by dyeing the wood with green water stain, then finishing with shellac and wax. Other effects may be obtained by using various colored paints or enamels. If an enamel is used, it is suggested that a coat of shellac be applied to the bare wood; then rub with steel wool before applying the enamel. In this way, usually one coat of enamel will suffice. Clean enamel brushes with turpentine.

Name Pin

The carved name pin is always a much appreciated gift and allows for originality in design on the part of the whittler. The number of letters in the name or the initials will determine the size that each letter should be. The larger the letters, the easier it will be to perform the whittling but the over-all size of the pin should be approximately the size of the one illustrated in Fig. 12.

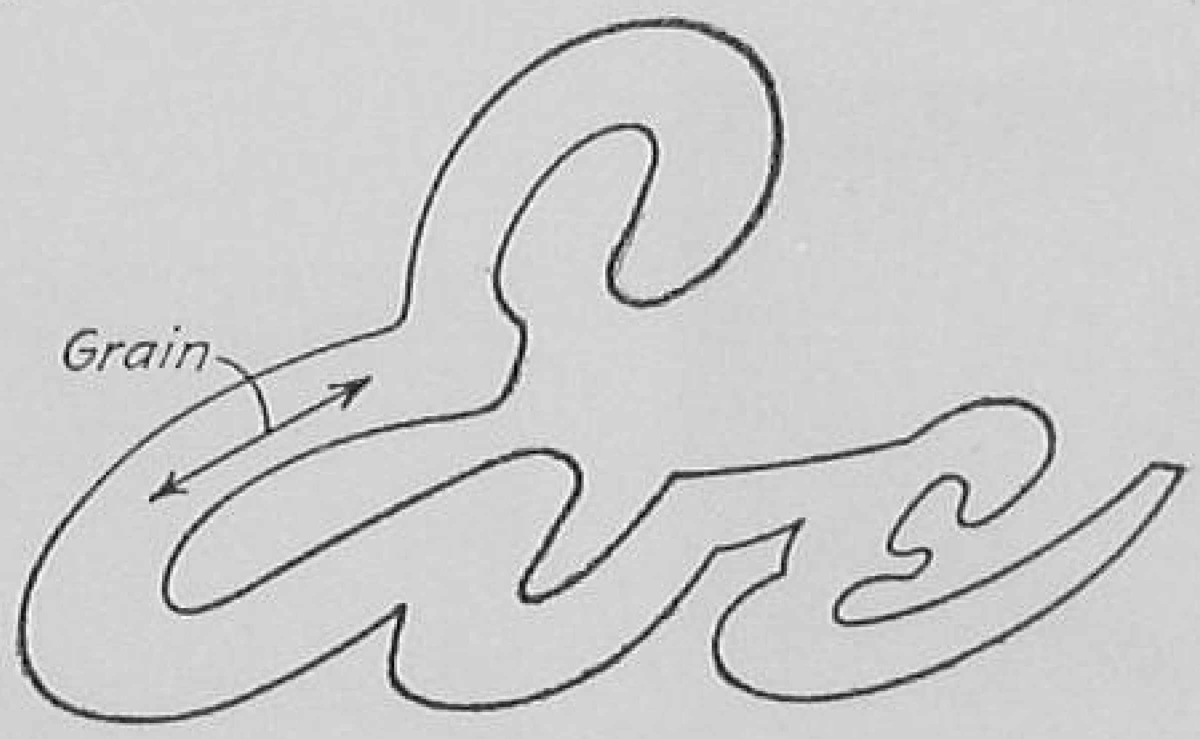


Fig. 12. Name pin.

The name pin "Eve" was cut from the same size blank as that used for the leaf pin. The slant of the letters is layed out to run in the direction of the grain as this will lessen the chances of the top portions of the letters being broken.

Considerably more care must be taken in sawing with the coping saw and in using the knife on this job as the structure is more delicate than the leaf. Care must be taken in holding the piece while whittling as too much pressure of the fingers may also break off sections of the letters.

The types of finish suggested for the leaf may be used on the name pin.

Scotty Dog

The scotty dog is submitted as a popular figure and one on which the whittling of detail and facial expression may be practiced. For this pin, a wood blank $\frac{3}{8}''$ thick, $3\frac{1}{2}''$ wide, and $2\frac{1}{2}''$ long should be used. Note the direction of the grain.

After the blank has been whittled to the outline and the edges rounded, work on body detail may be started. The body is made to stand out by a partial whittling away of the area between the hind legs and the side. The area around the neck is recessed and the tail is pointed at the tip.

The paws can be emphasized without going into great detail by simply removing chips from around the ankles. This is done by making a V-shape cut.

One eye is shown by scoring a small circle with the point of the knife blade, then with the point tilted slightly, cut into the scored line working in the opposite direction removing a V-shaped chip.

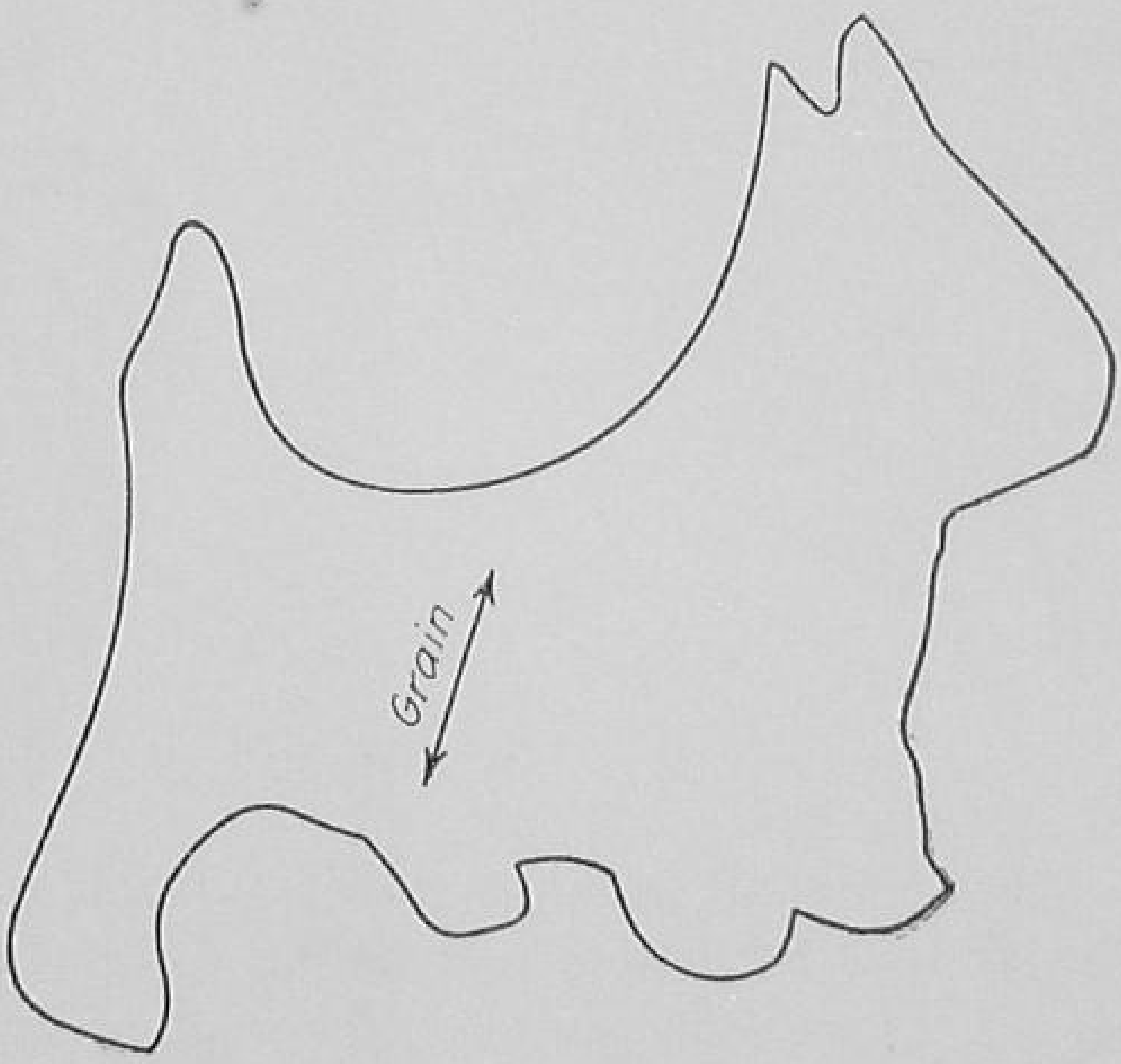


FIG. 13. Scotty dog pin.

The hair of the scotty is represented by narrow V-cuts made about the head and body. Sanding and finishing are done as described for the leaf.

A satisfactory finish may be obtained by mixing some powdered lamp-black with shellac and applying in the same manner as clear shellac. Several coats, rubbed with fine steel wool between coats, will produce a nice black scotty.

Bird Pin

A blank ½″ thick, 2½″ wide and 4″ long is used for this pin. After cutting the design with the coping saw, the head and tail are cut down to one half the thickness of the wood which allows the wing to stand out. The section under the tip of the wing may also be cut away from the back of the blank one half the thickness of the wood to give less bulk and to aid in making the wing tip stand out. The detail lines representing the

feathers and the beak are made by using the point of the knife to make V-cuts.

If a dark wood such as walnut or mahogany is used, the wing may be finished in natural color and the body painted to suit the individual's taste.

FIG. 14. Bird pin.

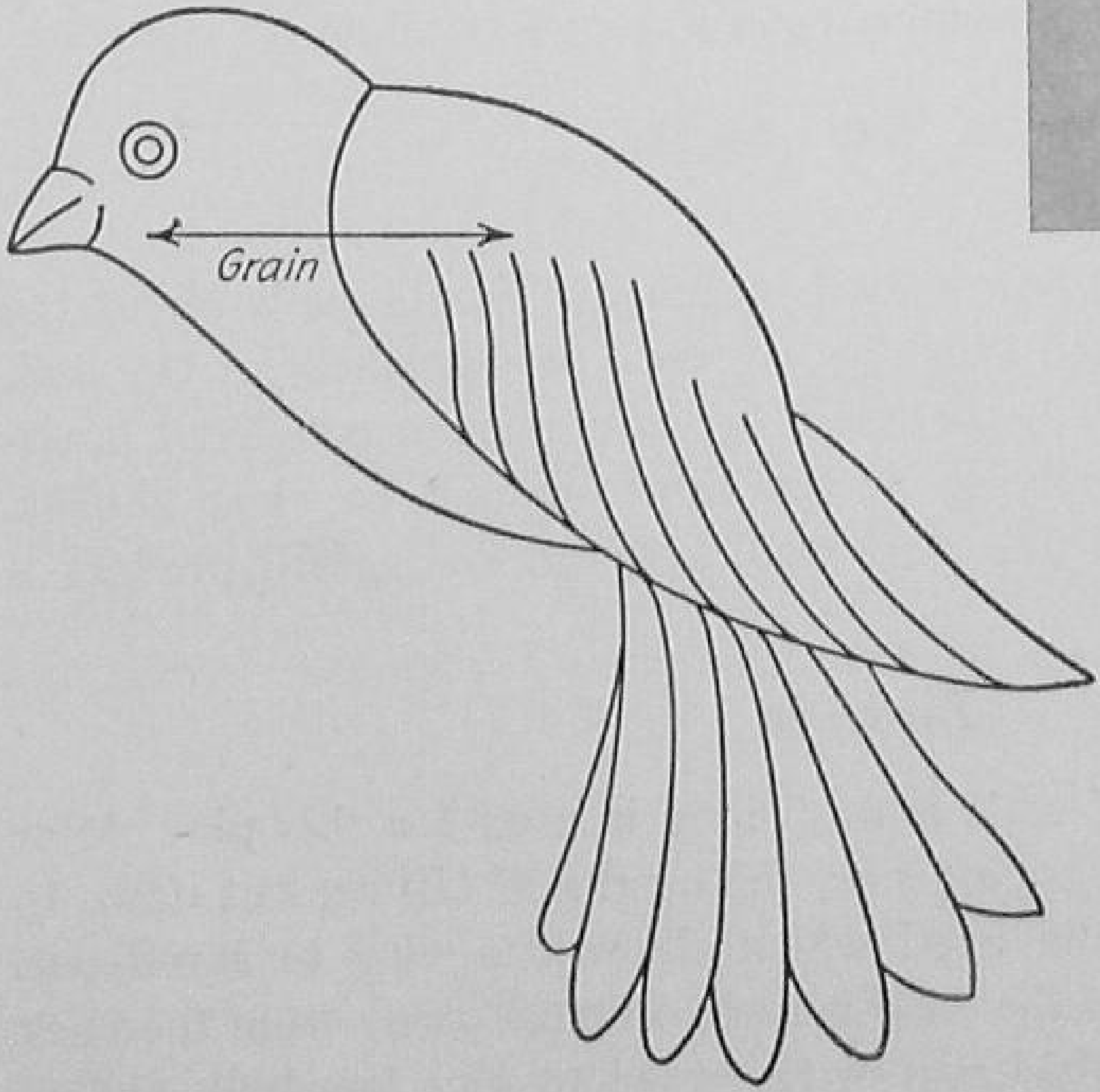


FIG. 15. Bird pin.

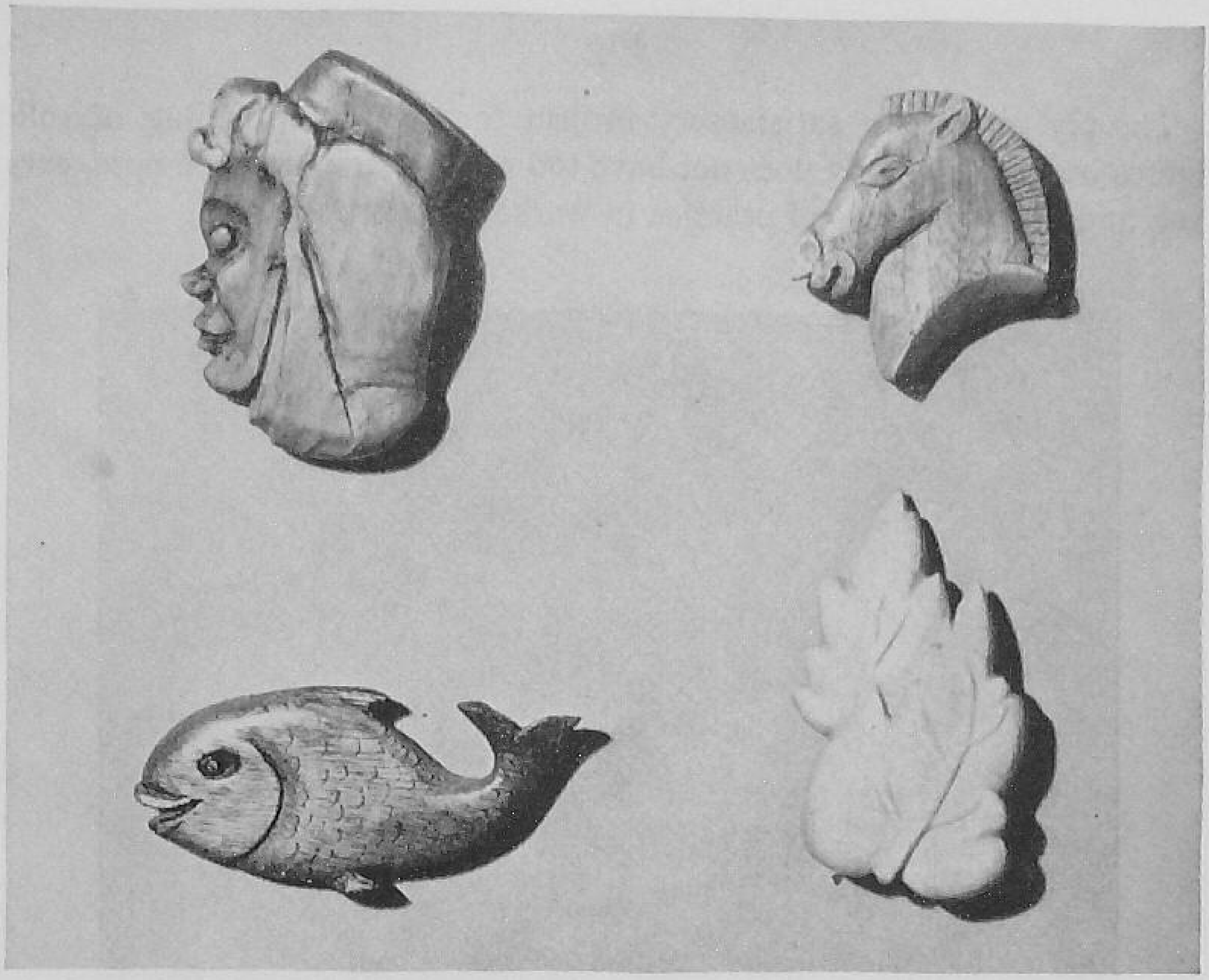


FIG. 16. The above pictures show additional pins which are typical of the jobs which may be done by the whittler.

GROUP II—SOLID FIGURES

This group offers a somewhat greater challenge to the whittler. These figure carvings, as they are sometimes called, are three-dimensional in nature and therefore are adaptable to a more satisfactory expression of one's capabilities. Whittling animals, such as the pig, is relatively simple since facial expression and shape of body are easily detailed. Whittling a human face or figure becomes an art rather than a craft due to the fine details required in showing facial expression.

On solid figures, the whittler follows almost the same procedure that he did on the flat-type work except that care must be taken to make the figure symmetrical. The design is layed out on the block of wood; the excess wood is removed by a coping saw; and the whittling can begin. The keeping of symmetry is aided by drawing a center line completely around the block after the excess wood has been removed.

Pig

The pig provides a satisfactory project for practice whittling of solid figures because the body does not have too much detail, and the nose, ears, feet, and tail provide good practice in working on projections.

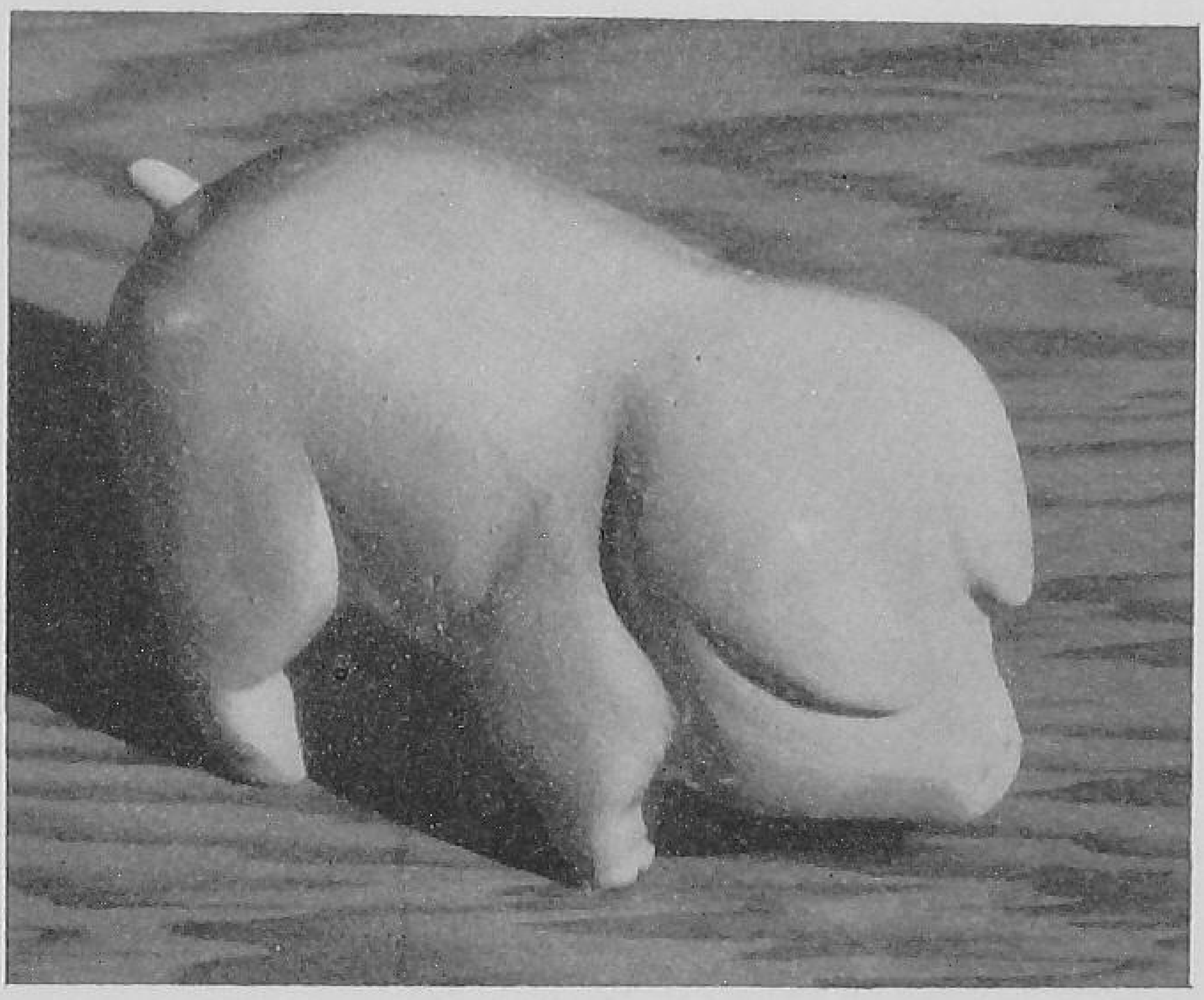


FIG. 17. The pig.

1. Trace the full-size pattern (Fig. 18) and transfer it with carbon paper and pencil to a block of wood 1⅜" thick, 3½" wide, and 2¼" long, using any of the woods described in the beginning of the chapter.

2. Remove the excess wood outside the outline with a coping saw, then gage a pencil line around the center of the block as indicated in the drawing.

3. Outline the ears, head and front legs as shown in the front view (Fig. 19) and begin shaping to these lines. Remove the wood from the snout so that it tapers toward the center, working first on one side of the center line and then on the other.

4. Outline the rear view and round the body but do not cut the tail down to finished size as it may break off in holding the piece of wood.

5. The areas between the forelegs and the hindlegs are removed by making a series of V-cuts until proper depth and width have been obtained. The legs can then be shaped to size.

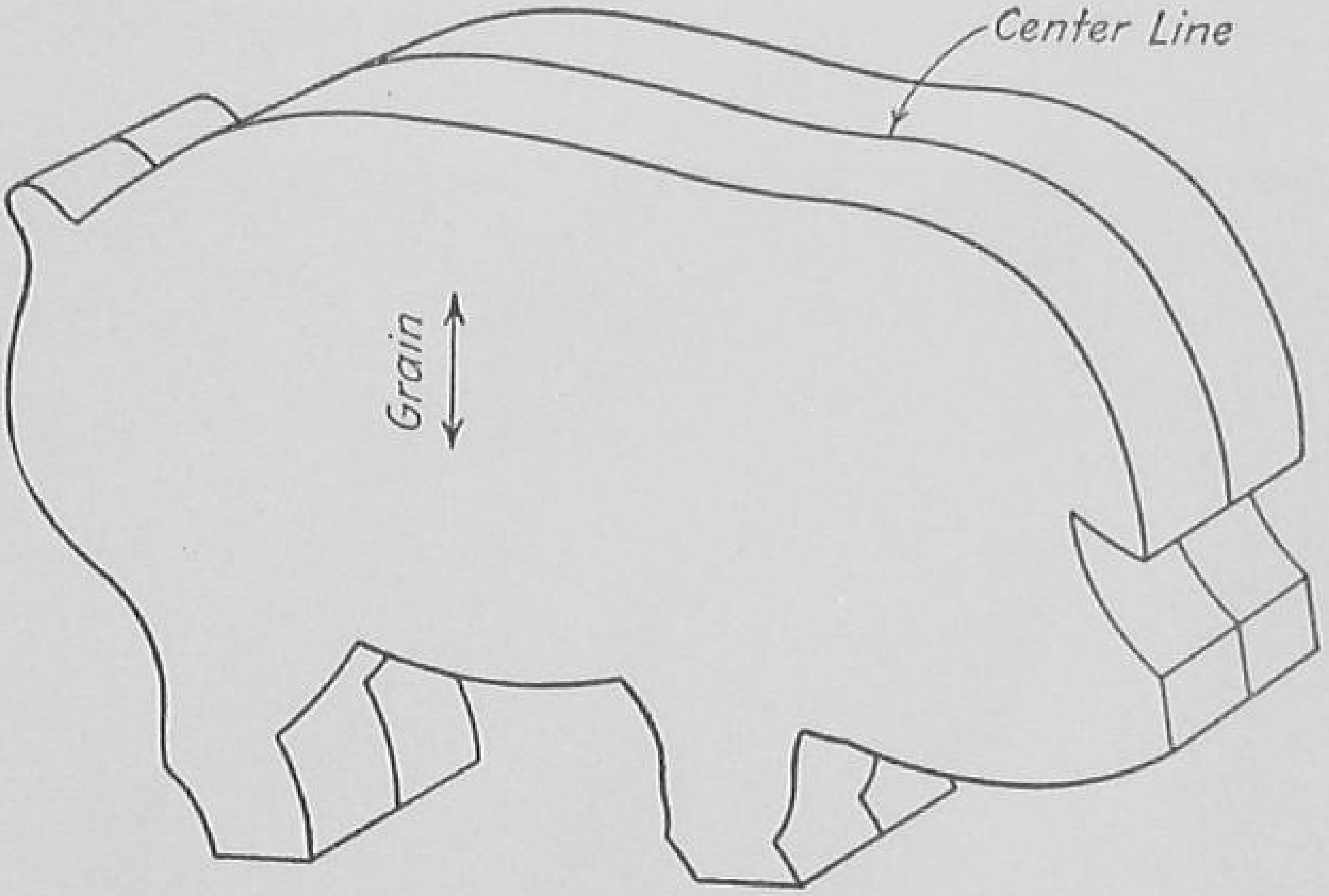


FIG. 18. Pattern of the pig.

6. Details such as the nostrils and toe clefts are added, the tail is finished to size and the job is ready for finishing.

7. Sand all parts thoroughly with 2/0 sandpaper, then finish with 4/0. The final finish will be in accordance with the whittler's desires. A natural

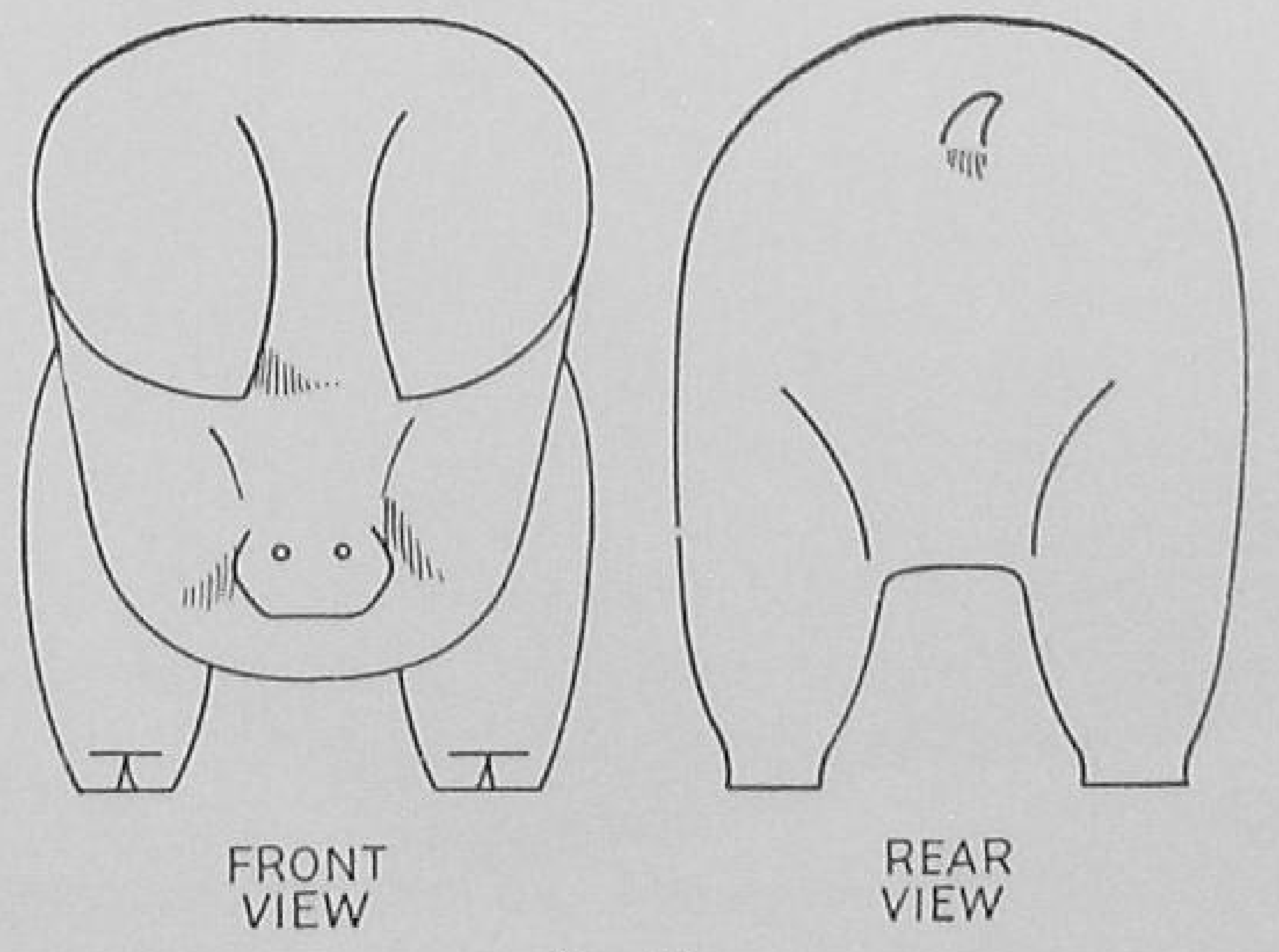


FIG. 19.

shellac and wax finish may be used depending upon the kind of wood, or the pig may be painted with white enamel or any combination of black and white, black, brown or pink.

Fig. 20. The rabbit.

Rabbit

The procedure for the rabbit (Fig. 20) is exactly the same as that for the pig. The size of the block of wood used is 1¾″ thick, 3¼″ wide and 4″ long. After cutting the outline with a coping saw, start whittling be-

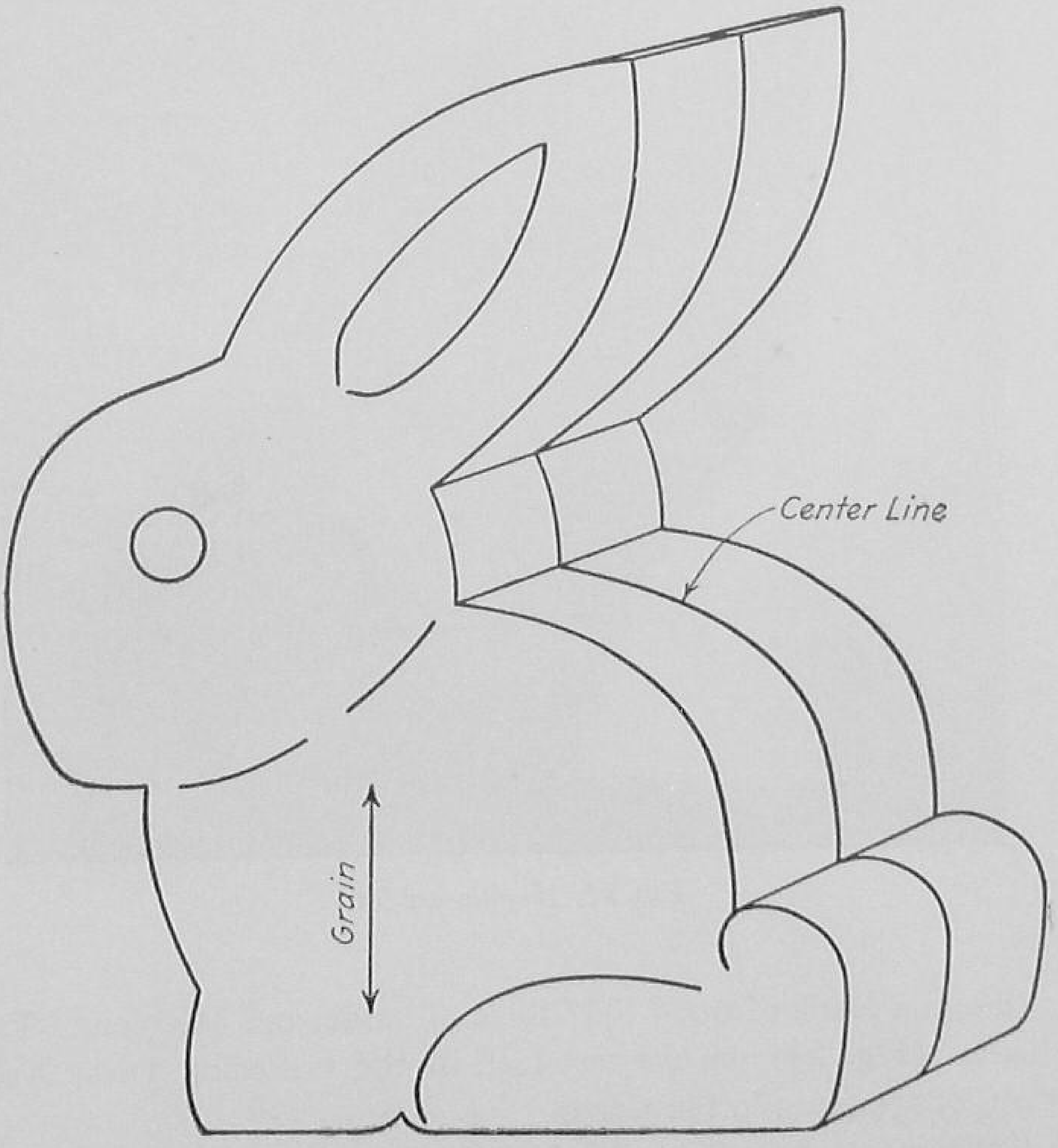


Fig. 21. The rabbit.

tween the ears by making a series of V-cuts until proper width has been obtained. The space between the ears is wider at the top than at the bottom.

Napkin Holder

The fish napkin holder is suggested for slight variation from the other solid models. A whittling project may be useful as well as ornamental and

this sample is described to show how objects may be developed or copied and given a more personal touch by whittling them from wood.

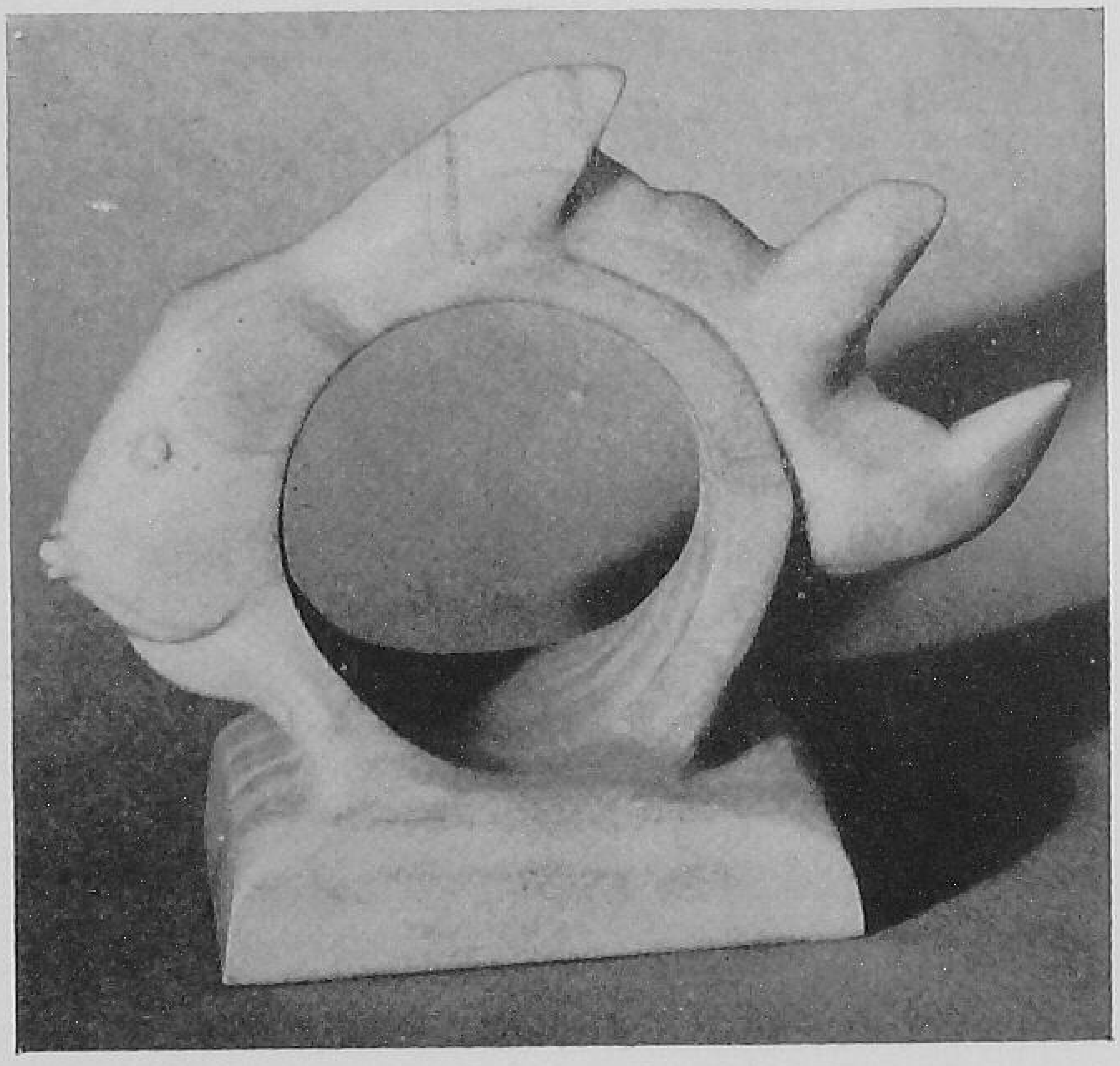


FIG. 22. Napkin holder.

1. Obtain a blank of wood 1¼″ thick, 3″ wide, and 3½″ long. Transfer the design (Fig. 23) on the wood as in the preceding jobs. Note the direction of the grain in the wood.

2. Cut the outside outline with a coping saw so that the block will look like the side view in the drawing. Lay out a center line around the project.

3. Next, lay out the thickness of the figure as shown in the end view. Remove the excess wood from both sides with a coping saw.

4. Lay out the circle and just inside the circle line, in the wood to be removed, drill a small hole just large enough to admit the blade of the coping saw. Insert the blade in the hole and saw just inside the circle line, removing the wood.

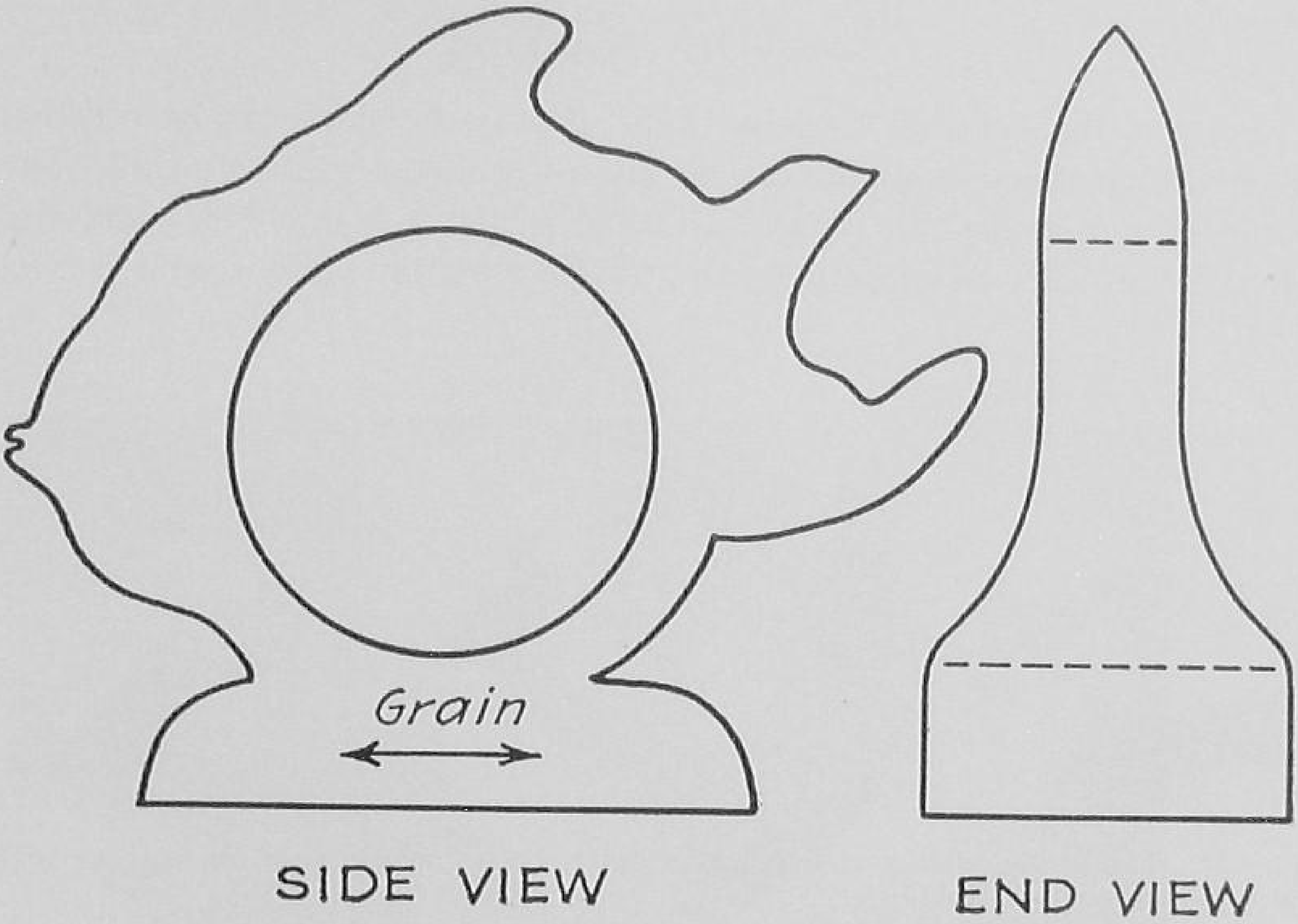


FIG. 23. Pattern for the napkin holder.

5. Lay out the head as shown in Fig. 24 and start whittling to shape. Add the eyes and outline the gills with shallow V-cuts, made with the point of the knife, to bring them into relief. Round out the ring.

6. Sand and apply finish desired.

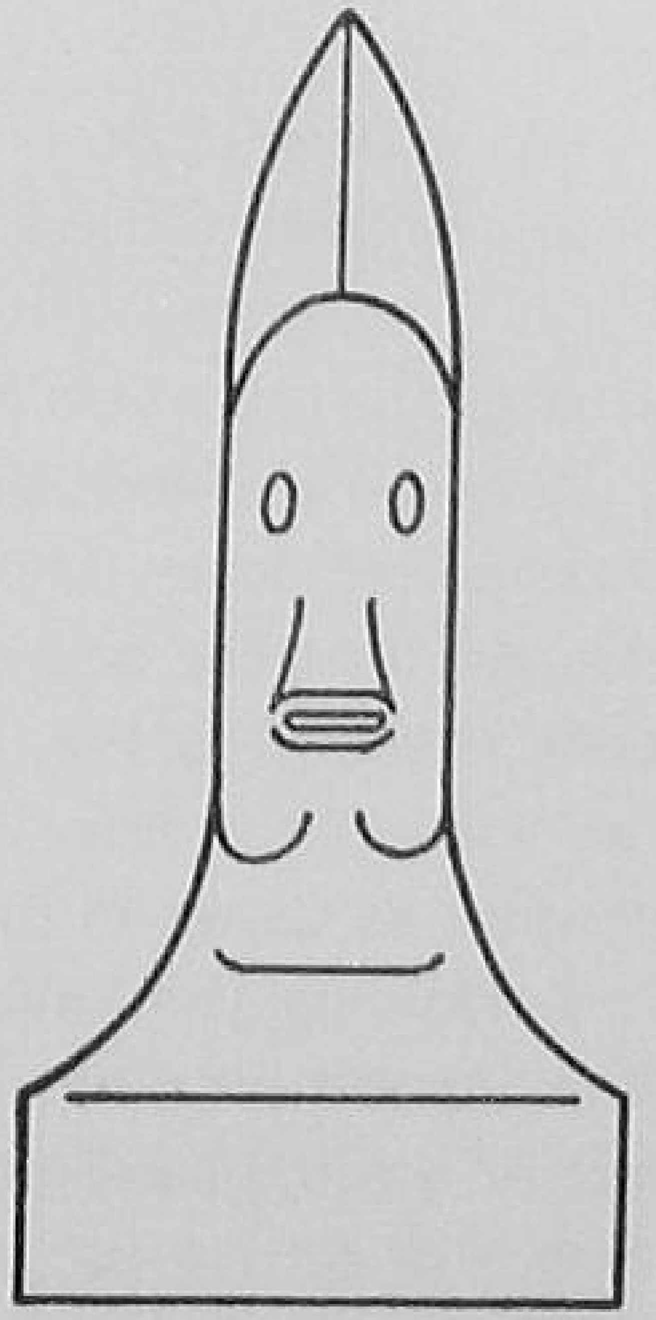


FIG. 24. Front of the napkin holder.

Group III—Novelties

Some of the so-called "novelty" type of projects which can be whittled have no functional value but are merely a test of the whittler's skill. The value of performing this type of whittling is that it is interesting and also gives the whittler an opportunity to practice using the knife to gain greater skill.

Fig. 25. The above photograph indicates other figures which may be used as suggested projects for the whittler.

Chain

The wooden chain is probably one of the most interesting of the novelty projects. The whittler may vary the dimensions to suit his requirements but it is suggested that the dimensions used below be followed in the first attempt, as this chain is large enough to be handled with ease.

1. Procure a piece of soft, straight-grained pine 1½″ square and approximately 18″ long. Divide each surface into three equal parts and draw straight lines the entire length of the piece. Extend the lines around the ends as shown in Fig. 26, which will leave a group of squares showing on the ends of the piece. With the pencil lead, darken the outside corner sections as shown in the picture. This indicates the parts to be cut away.

2. Holding the knife, as shown, cut as deeply as possible along each line. As the cut progresses toward the opposite end of the piece, move the left or holding hand to a position in back of the knife blade to avoid the chance of getting cut. The wood in the blackened section is removed by a series of cuts until the piece of wood is cross-shaped as shown in Fig. 27.

3. A cardboard or wooden pattern is made and the shape of the links is laid out on the piece of wood by use of the pattern as shown in Fig. 27.

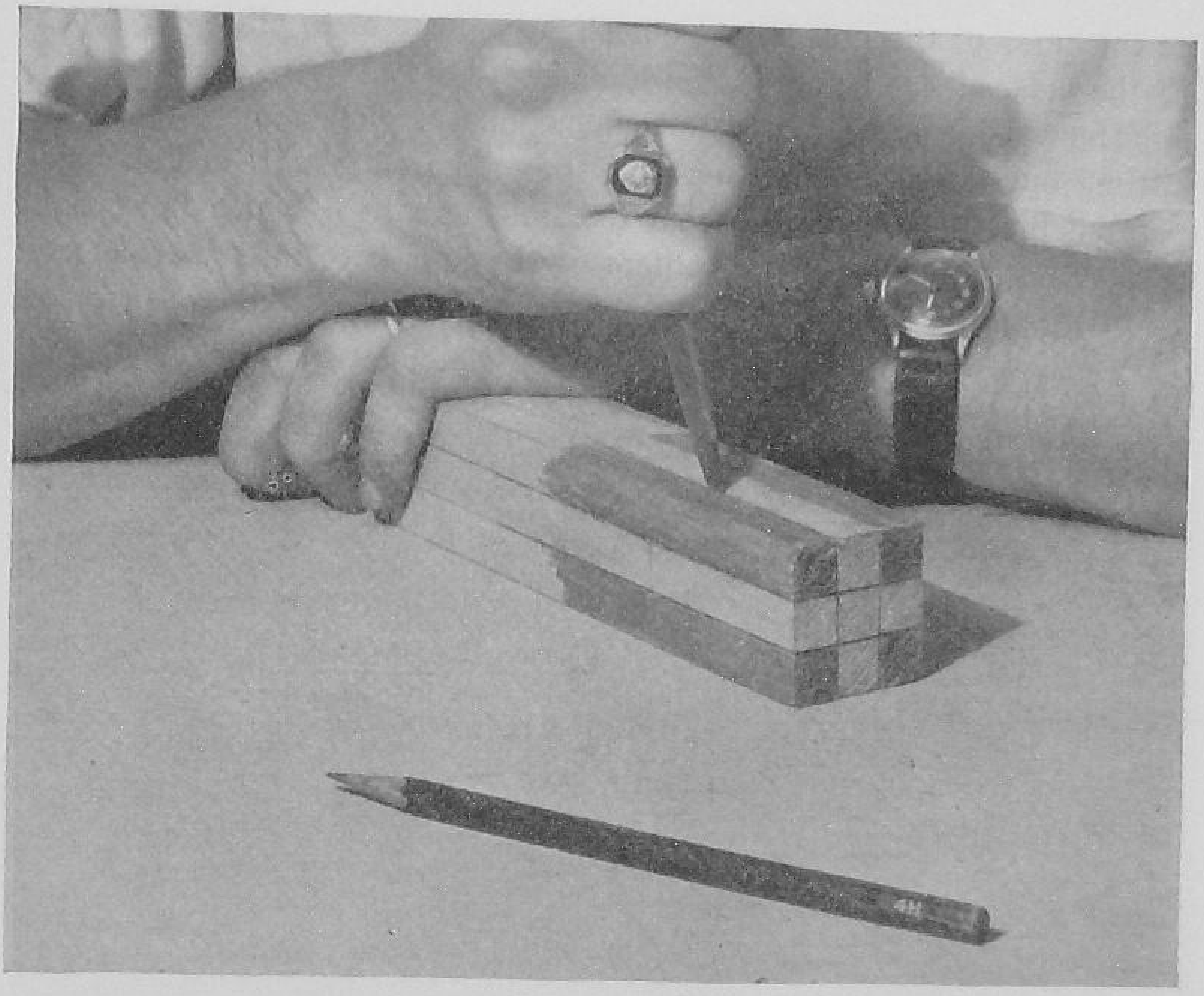


FIG. 26. Layout of the wood for a chain.

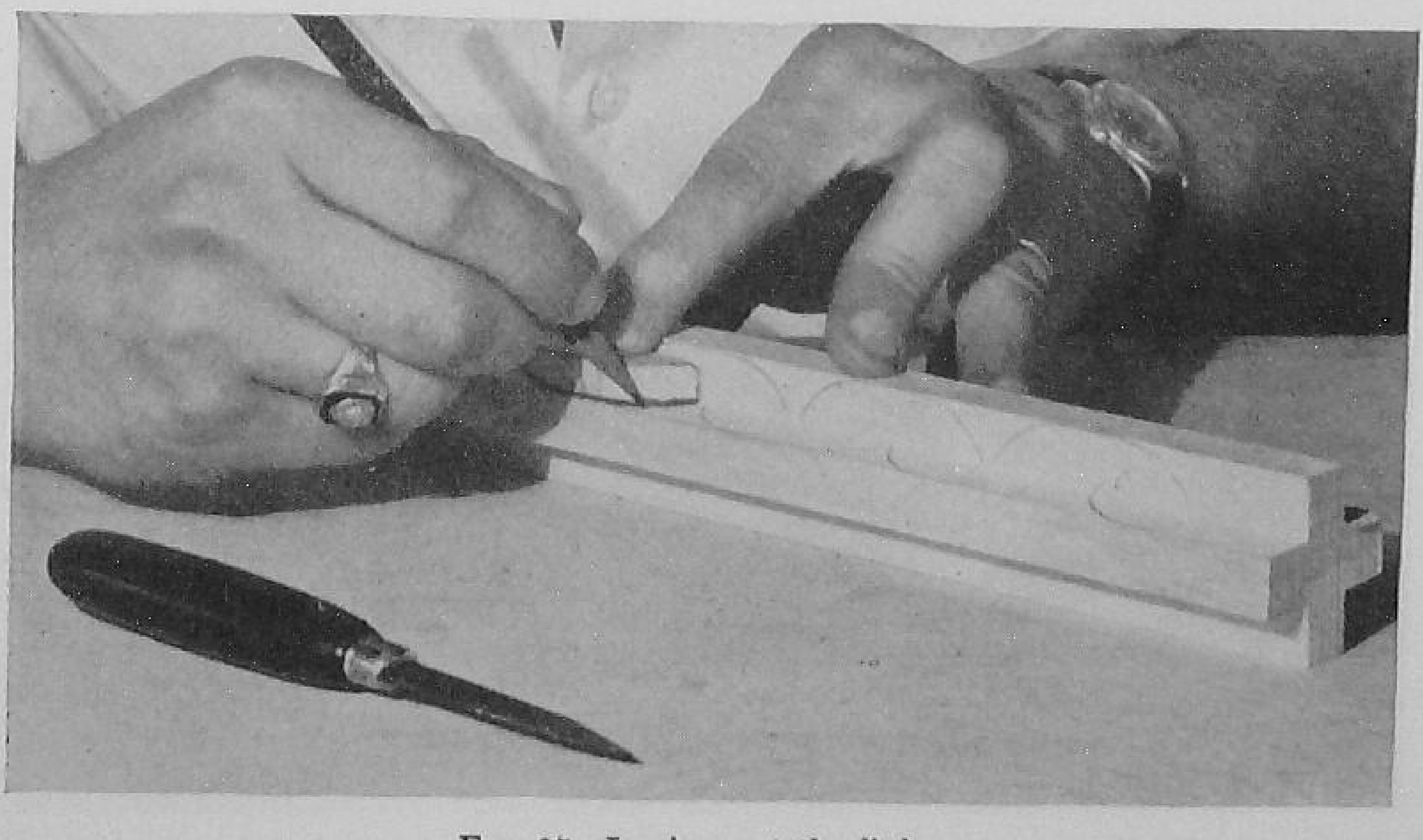


FIG. 27. Laying out the links.

The thickness of the link is laid out slightly oversize to allow for finishing; the finished size being $\frac{5}{16}''$ in diameter.

4. The outside edges are now roughed out as shown in Fig. 28. In whittling out the centers of the links it is apparent that the link being separated first must be freed from the link next to it which is at right angles. In starting the chain, centers of the first two links are removed

Fig. 28. Roughing out the outside edges of the links.

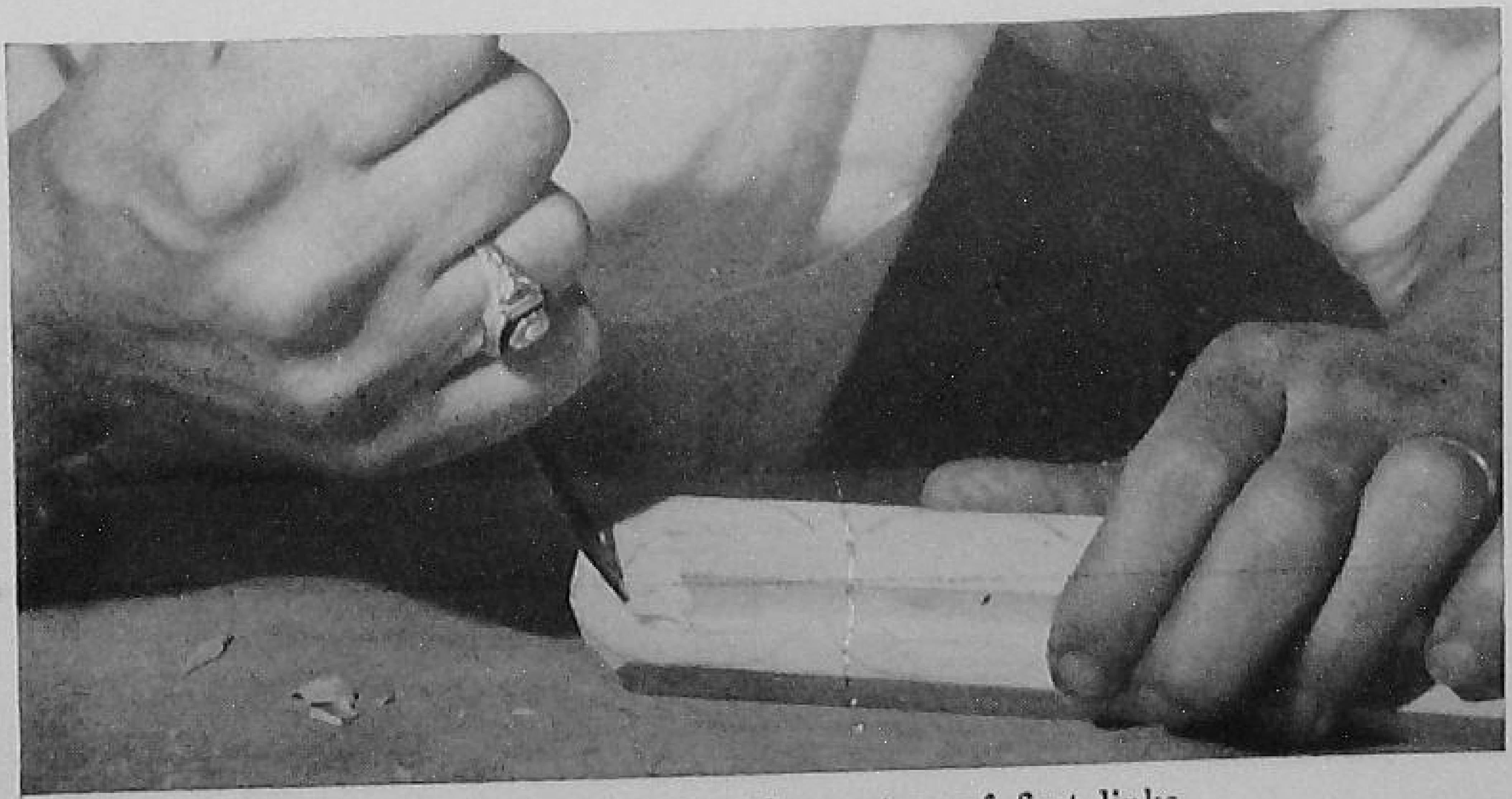


Fig. 29. Roughing out the centers of first links.

(Fig. 29) simultaneously, thereafter clearing only one at a time. This lessens the chances of breakage as work progresses.

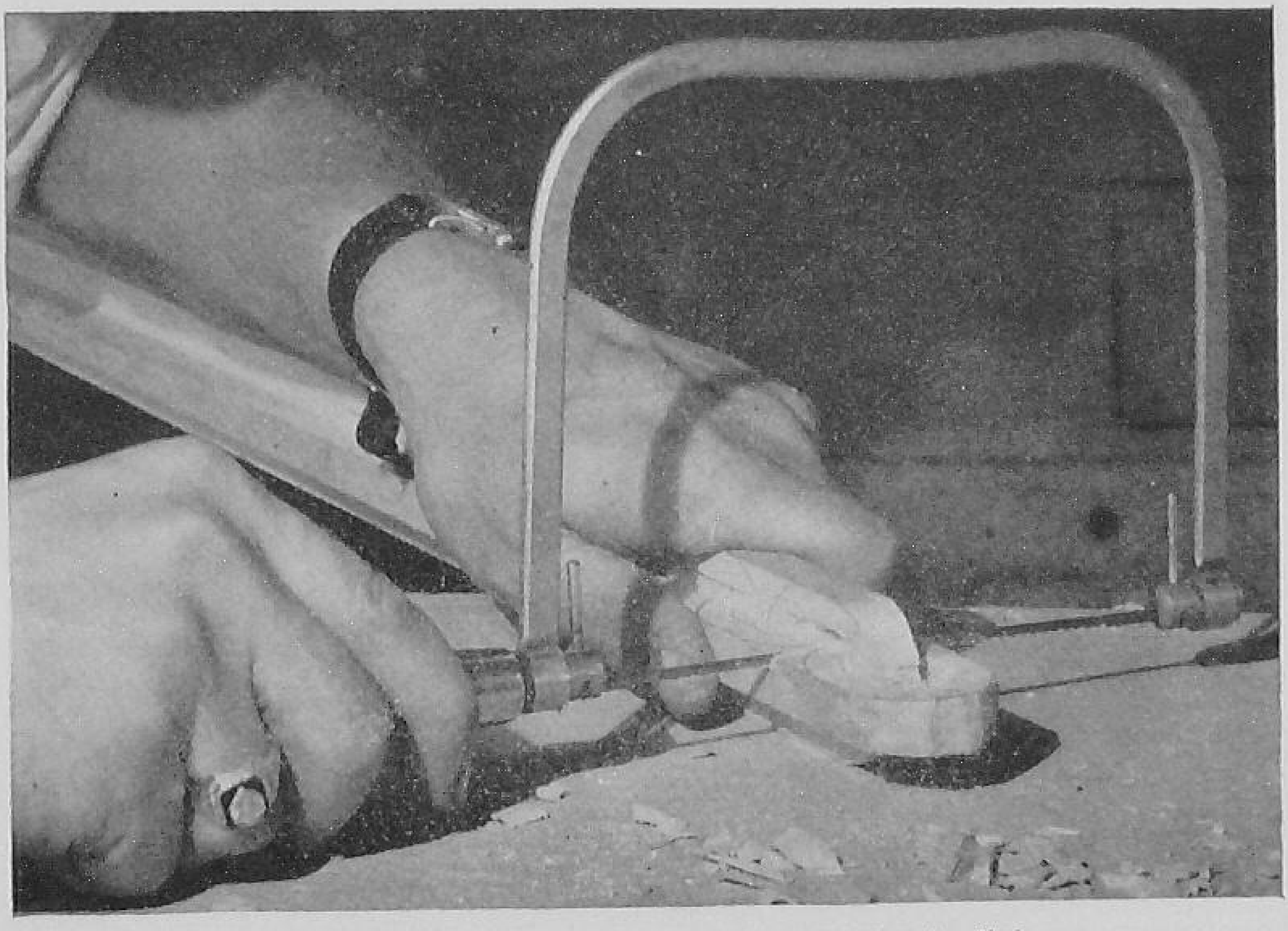


FIG. 30. Using coping saw to help separate the links.

FIG. 31. Final clearing of the links.

FIG. 32. Finish cutting the links.

5. After clearing the centers of the first two links by whittling first from one side, then from the other, a coping saw blade is inserted through the center of one link and a cut is made through the end of the link which is at right angles to it (Fig. 30). This severs the end of the link so that final clearing may be done by a series of V-cuts into the saw kerf just made.

6. The process of clearing and separating of links is completed with a sharp-pointed knife in the manner shown in Fig. 31.

7. Each link is smoothed down to the finished size as shown in Fig. 32.

8. Sand each link (Fig. 33), taking care to thoroughly smooth the internal sections of the link. Several coats of wax rubbed into the wood will provide an adequate finish which will prevent the natural wood from becoming dirty in handling.

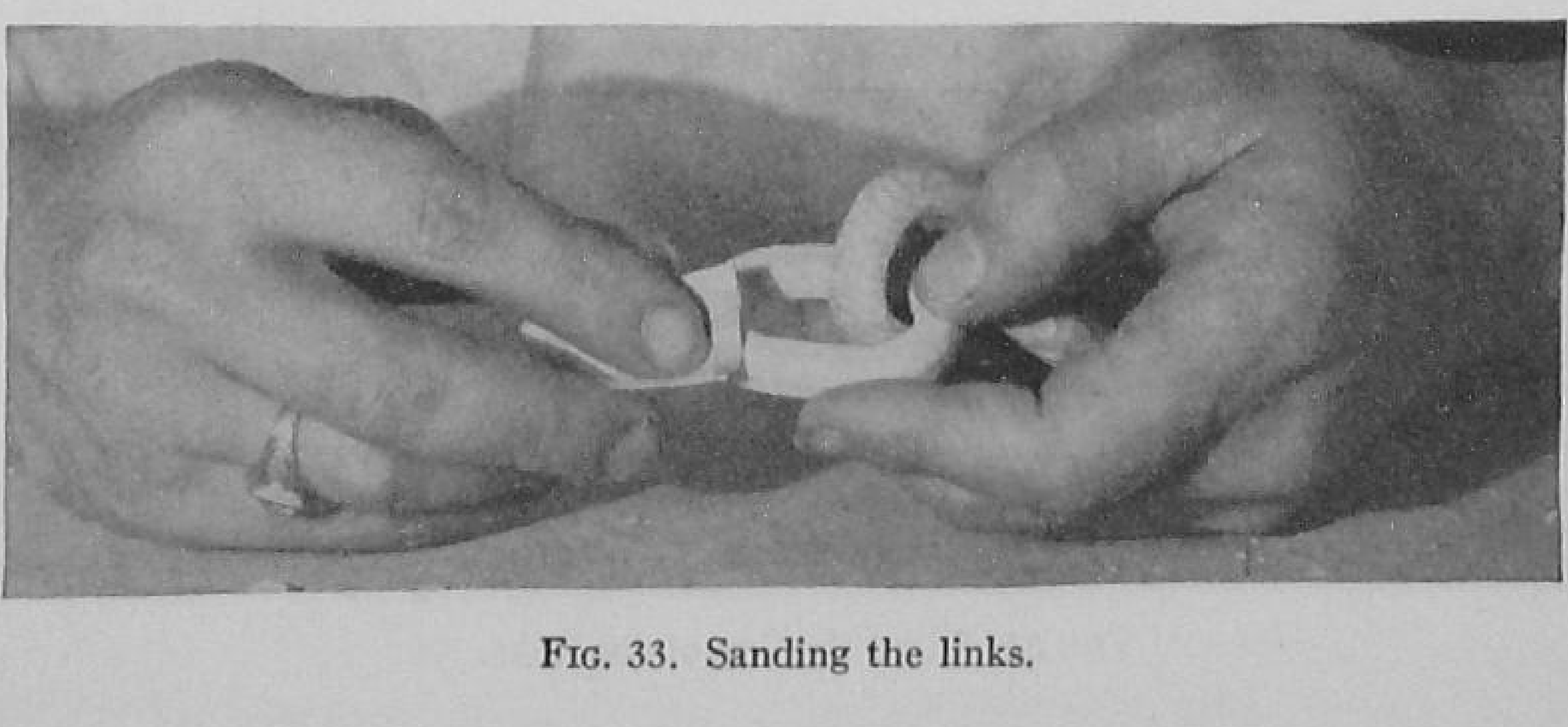


FIG. 33. Sanding the links.

References

1. Hellum and Gottshall, *You Can Whittle and Carve,* Milwaukee: Bruce Publishing Co.

2. Ben Hunt, *Ben Hunt's Whittling Book,* Milwaukee: Bruce Publishing Co.

Chapter II

COPING SAW WORK

Woods to Use

The woods used to make the projects in this chapter are the same as those described in Chapter I. In addition to these woods, the woodworker should be familiar with plywood. Plywood is a composite board made by gluing together several sheets, usually three or five, of veneer (thin-sliced wood), with the grain of alternate layers at right angles to each other, and with the grain of the two outside layers running in the same direction. The layers are usually of equal thickness. However, in heavy plywood, the inside layers are sometimes thicker than the two outside layers. The inside layers, or core stock, are usually made of the same kind of wood as the outside layers. Plywood is very strong, flat and of uniform thickness. The alternate grain layers, together with the glue between the layers, minimize the changes in shape caused by moisture. Plywood can be obtained in a number of different kinds of wood, with either one or both sides smooth. It can be fastened together with nails or screws but projects should be planned so as not to require nailing into an edge or end.

Plywood is manufactured in a variety of sizes. The common sizes are ¼″, ⅜″, ½″ or ¾″ thick, 2′, 3′ or 4′ wide, and 2′ to 8′ long. It is best to determine the exact size needed for a project, and to ask a dealer for the nearest available size.

PROJECTS

Duck Sewing Kit

1. Make a tracing of the full-sized pattern.
2. Cut out the pattern with scissors.
3. Obtain a piece of softwood (pine, basswood or poplar) which is ¾″ thick and slightly larger than the pattern. The wood should be smooth on both surfaces.
4. Trace the design on one surface of the wood as shown in Fig. 36.

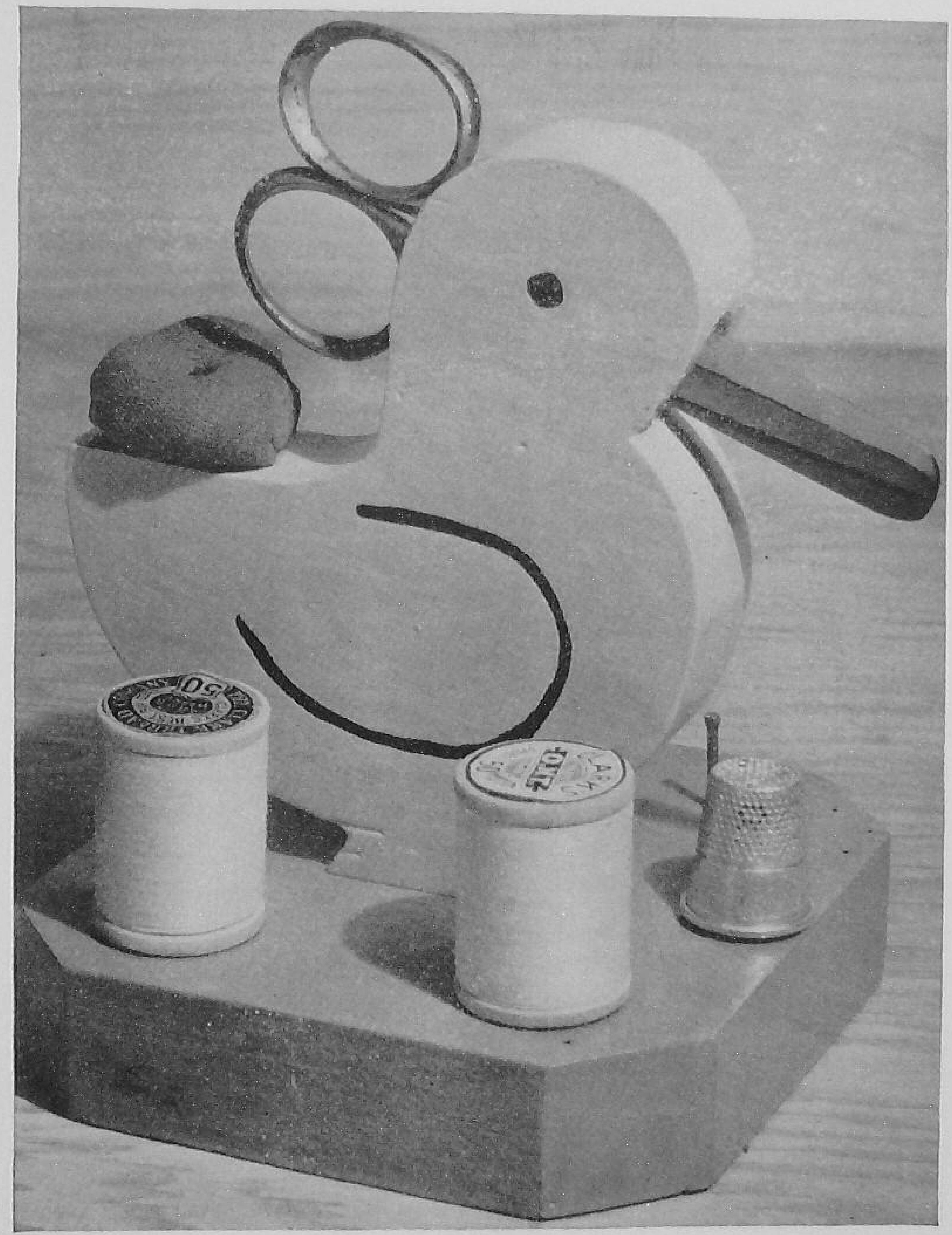


Fig. 34. Duck sewing kit.

5. Clamp the wood in a vise and, with the coping saw held in the position shown in Fig. 37, saw out the design of the duck. Leave enough of the line showing so that the edges of the design may be smoothed to the line.

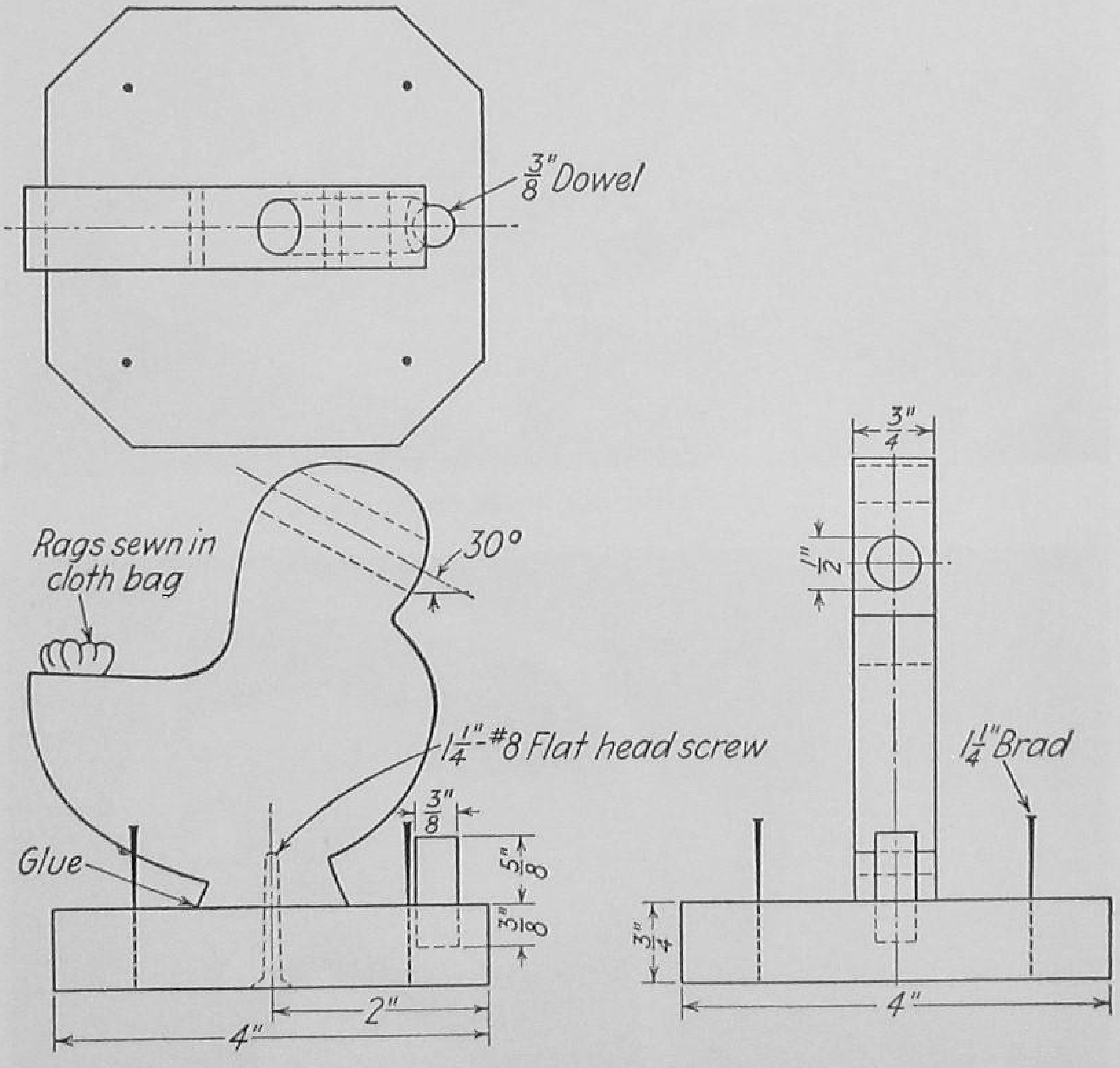


FIG. 35. Drawing of duck sewing kit.

6. The edges are now filed smooth, using a half-round woodworker's file as shown in Fig. 38. The woodworker's file is used to smooth edges and curves that are difficult to smooth with other tools. The cutting surface consists of sharp edged ridges or teeth. The cut of the file is determined by the spacing between the teeth and the angle at which the teeth cross the surface of the file. When there is a single series of teeth which run in parallel lines diagonally across the surface, the tool is known as a single-

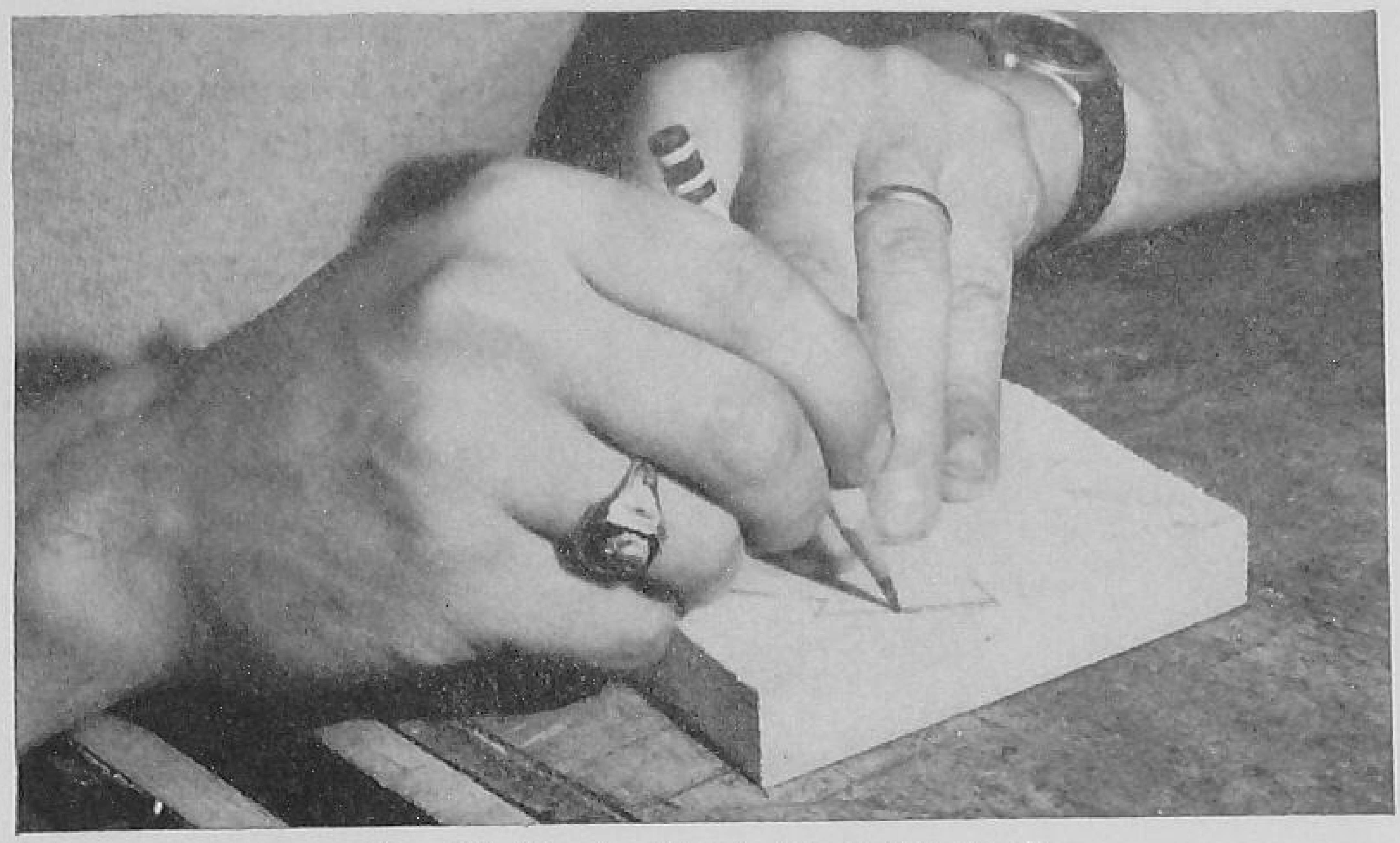


FIG. 36. Tracing the design on the wood.

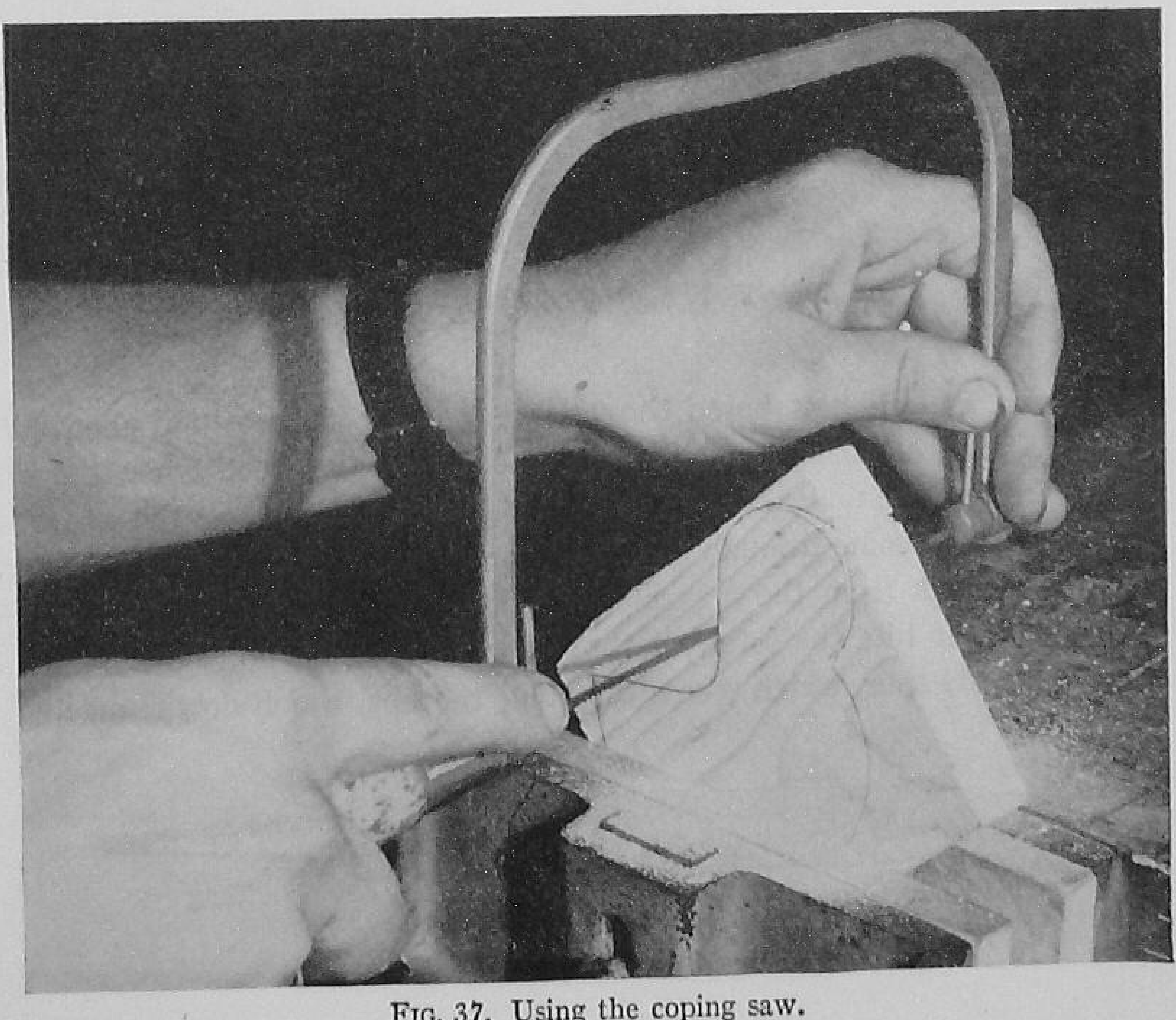


FIG. 37. Using the coping saw.

cut file. A double-cut file has a double series of teeth crossing each other at an oblique angle. Wood files may be obtained in a variety of shapes, such as round, flat, square, half-round, or triangular, and in lengths from 3″ to 14″ not including the tang.

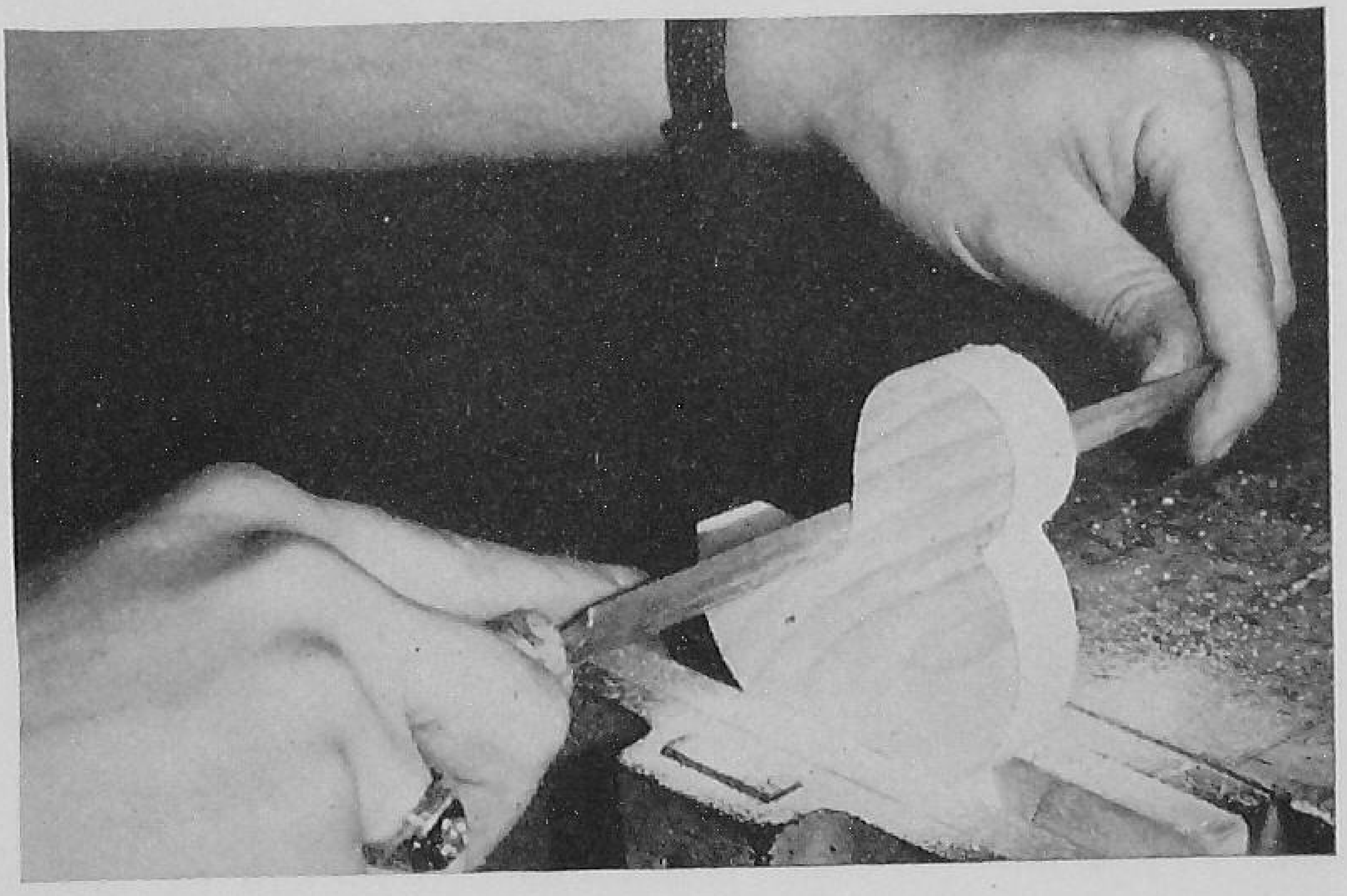


FIG. 38. Filing the edges of the duck.

7. A ½″ hole is now bored through the head in the position shown in Fig. 40. Care must be taken to prevent chipping the wood when the bit comes through the under side. To prevent splitting, as soon as the screw of the bit starts to come through the wood, remove the bit from the wood and start it through from the opposite direction. There are six parts to the common auger bit: the screw, a threaded point which pulls the bit into the wood; the spur, which scores the hole; the lips, which do the cutting;

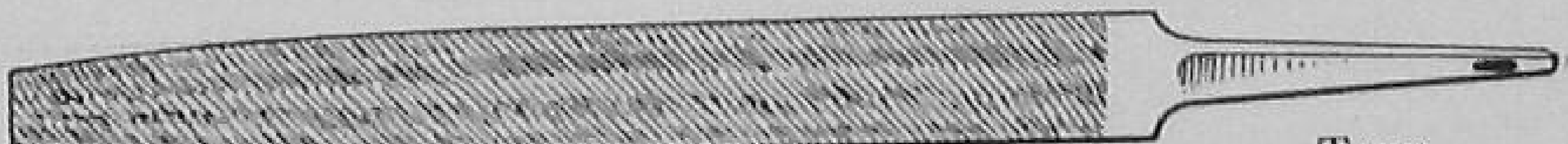


FIG. 39.

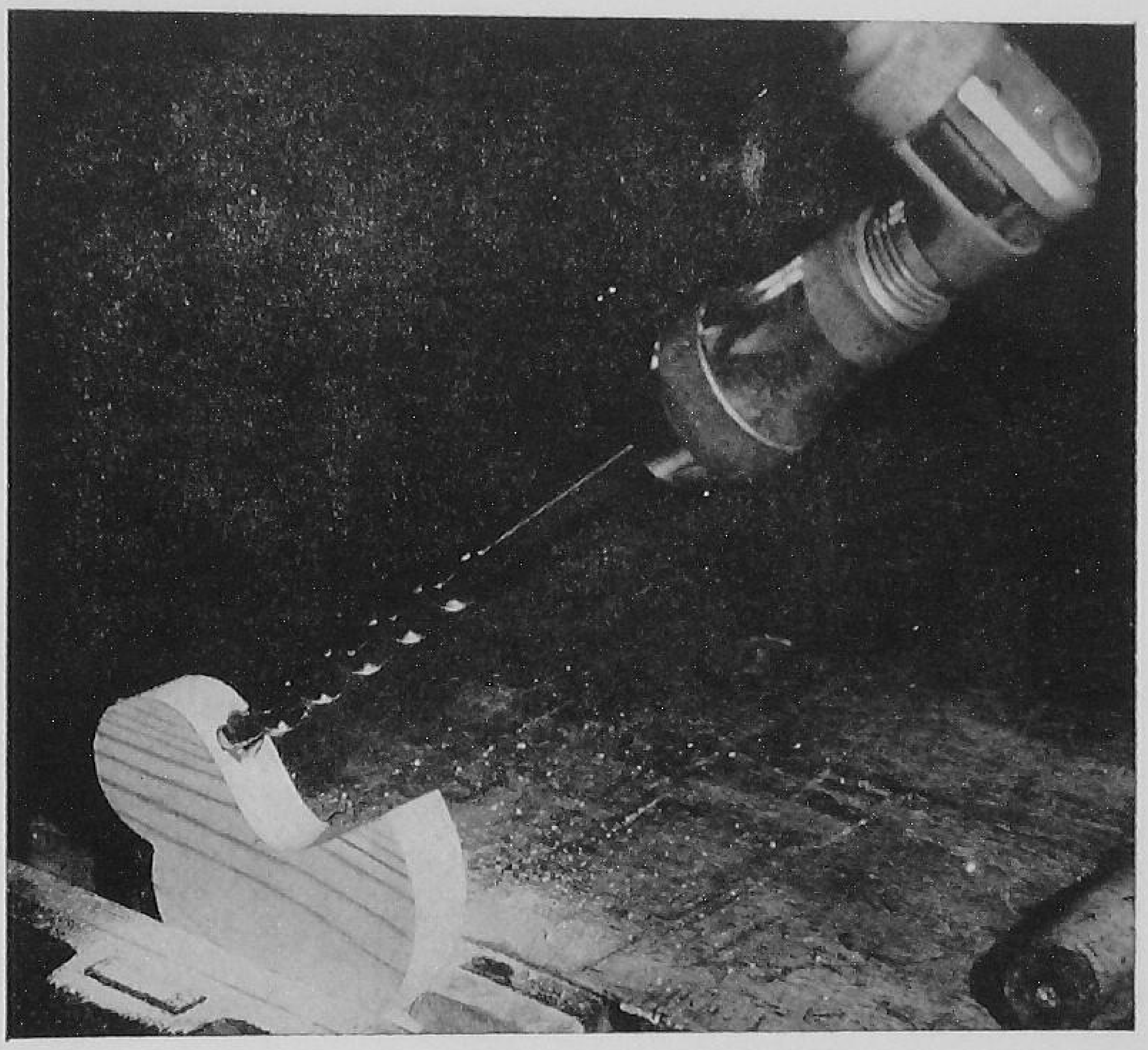


FIG. 40. Boring with a brace and bit.

the twist, a spiral flange which carries the chips out of the hole; the shank, which adds length to the bit; and the tang, a square part which fits into the brace.

The single twist auger bit has a solid stem or core running the entire length of the bit, making it a rigid, powerful tool with extra strength at the head. The double twist bit cuts a very smooth hole and is less rigid than

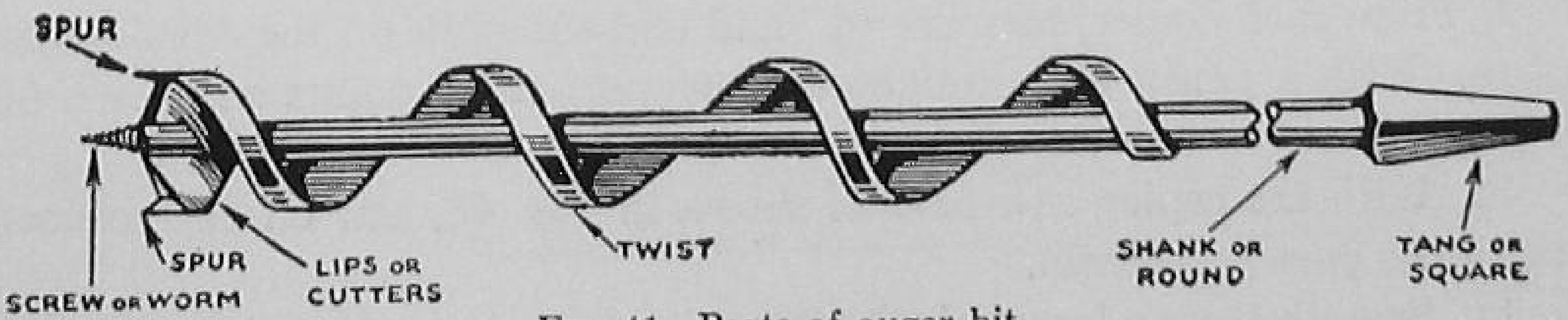


FIG. 41. Parts of auger bit.

the single twist bit. Both types of bits can be obtained in sizes increasing by 1/16″ from 1/4″ to 1 1/2″. A number on the tang indicates the size of the bit in sixteenths of an inch (see Figs. 41, 42, and 43).

Fig. 42. Single twist auger bit.

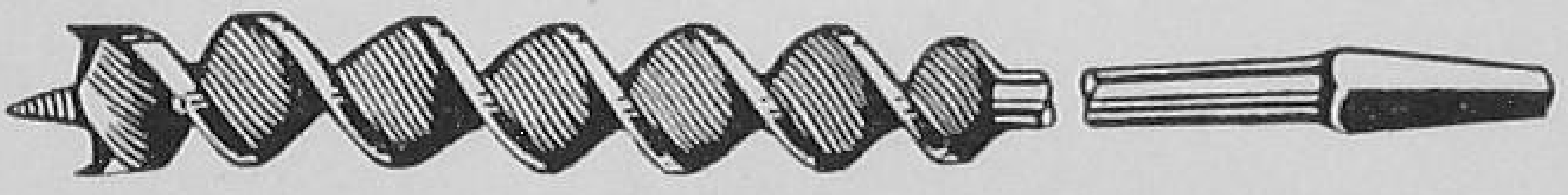


Fig. 43. Double twist auger bit.

The bit brace is a tool used to hold an auger bit or other boring tool. Braces are made with or without a ratchet. A ratchet is a mechanism on the brace which allows the chuck to rotate by a succession of partial turns of the crank. Braces are made in various sizes, measured by the diameter of

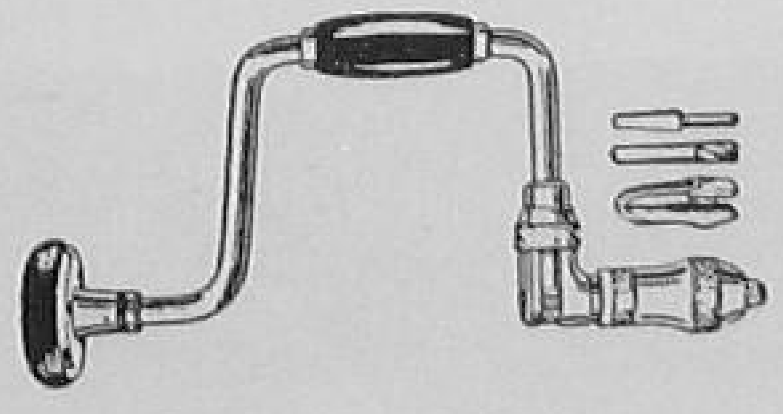


Fig. 44. Ratchet brace.

the sweep, which is the circle described by the crank of the brace. The common sizes of sweep are 8″, 10″, 12″, and 14″. The quality of a brace depends upon the type of jaws, the ratchet mechanism, whether or not the chuck and head are equipped with ball bearings, and the type of material used for the head and handle (see Fig. 44).

8. Obtain another piece of wood 3/4″ thick and 4″ square to be used for the base. Draw diagonal lines from corner to corner on one surface.

9. From each corner, measure 3/4″ and make a mark on the edge of the piece. With a pencil and straightedge, connect these points as shown in Fig. 45.

10. With the coping saw held as shown in Fig. 46, saw off the corners along the lines just drawn.

11. Smooth these edges with the flat side of the wood file taking care to keep the edges straight and square.

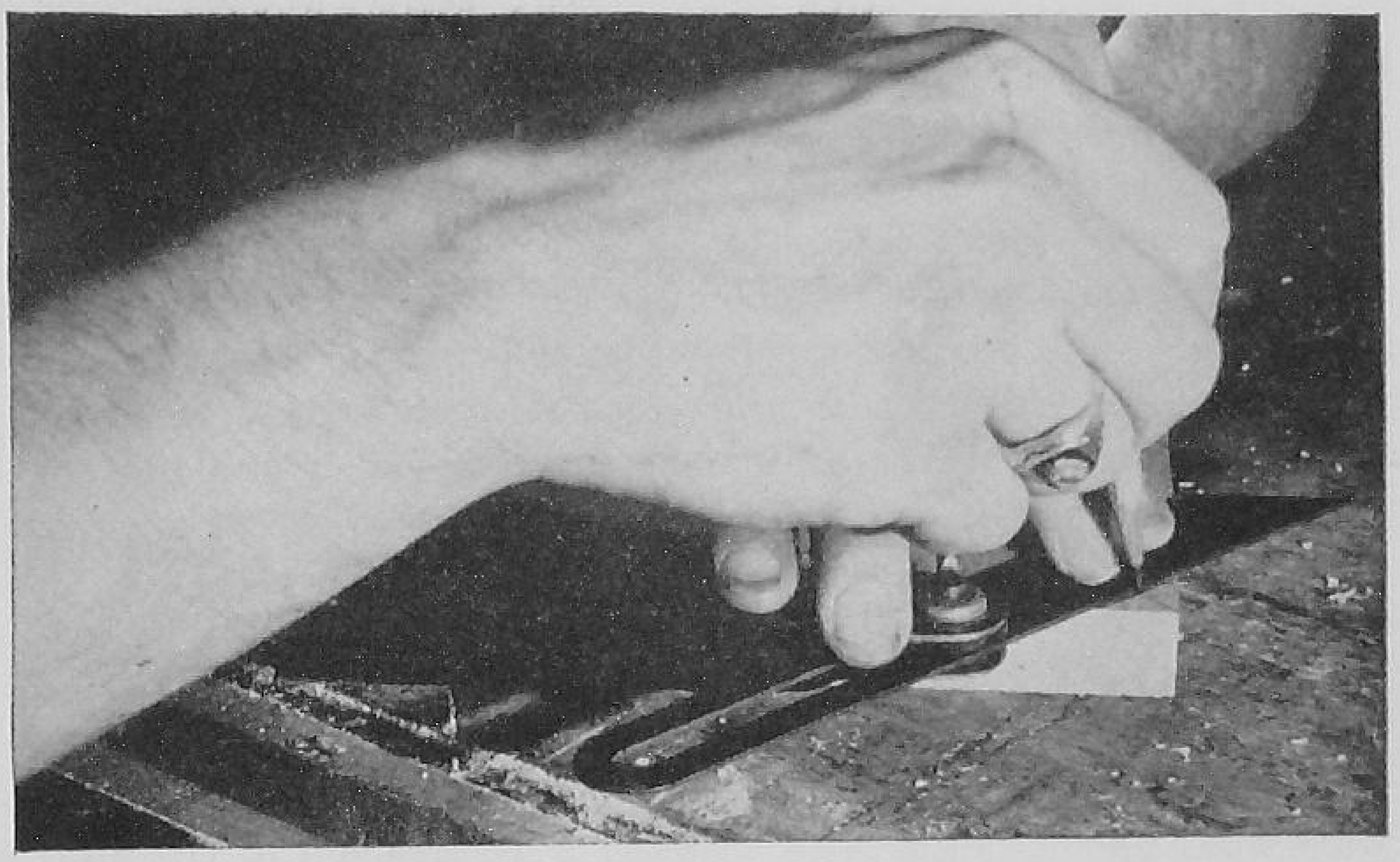


FIG. 45. Draw the diagonal lines across the corners of the base.

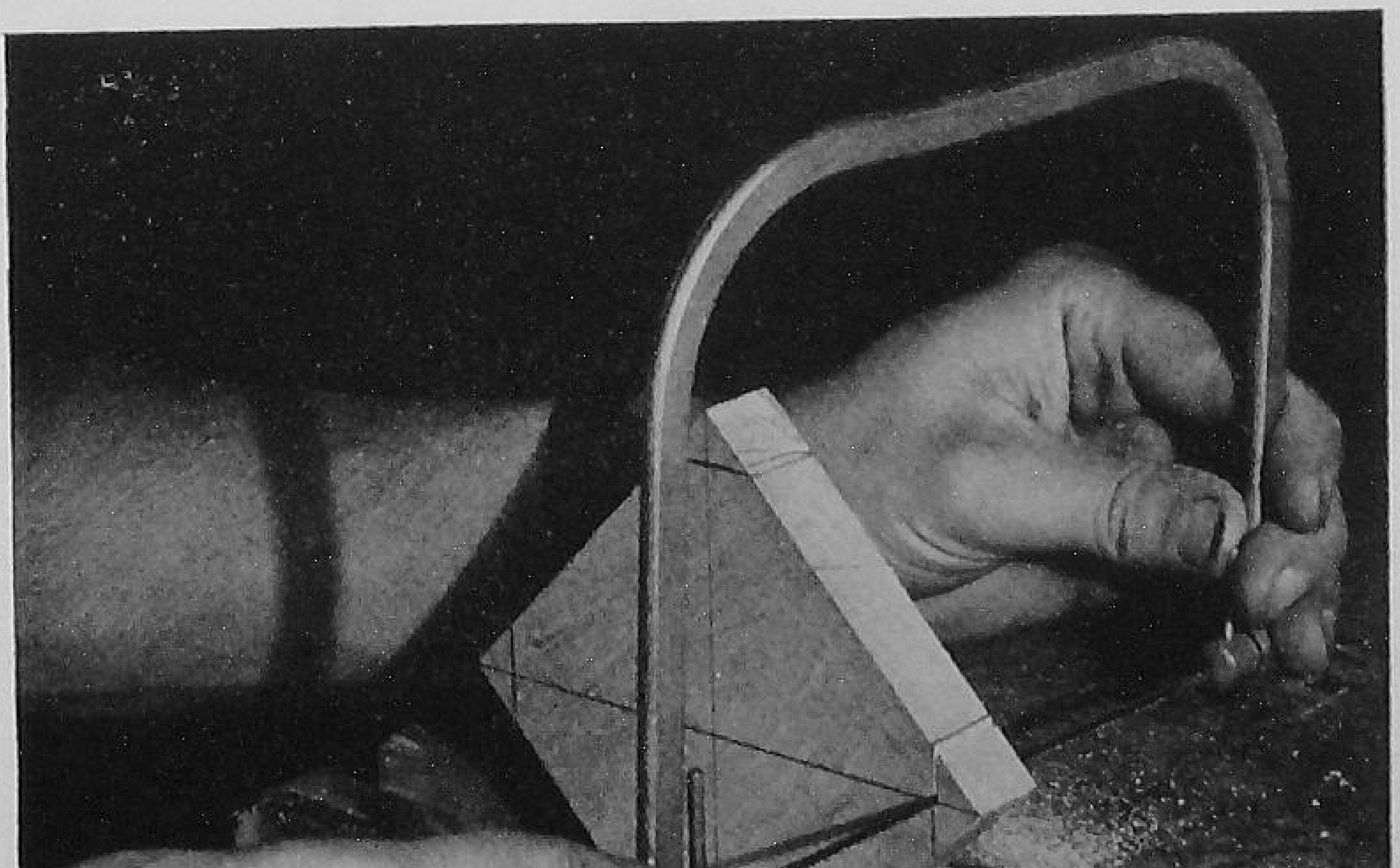


FIG. 46. Cutting off the corners with a coping saw.

12. Mark off the position for boring a $\frac{3}{8}''$ hole for the thimble holder. Bore the $\frac{3}{8}''$ hole halfway through the base piece, using a brace and bit.

13. Prepare the pieces for fastening with a $1\frac{1}{4}''$ No. 8 flathead screw. The number of the screw indicates the diameter, and screws are manufactured in diameters from No. 0 to No. 24. The No. 0 is approximately $\frac{3}{32}''$ in diameter. The lengths vary from $\frac{1}{4}''$ to $1''$ by eighths and from $1''$ to $5''$ by fourths. The length of a flathead screw is measured from the point to the top of the head. There are three standard types of head: flat, round, and oval. Many special types are manufactured for specific purposes. Steel and brass are the most common materials from which screws are made.

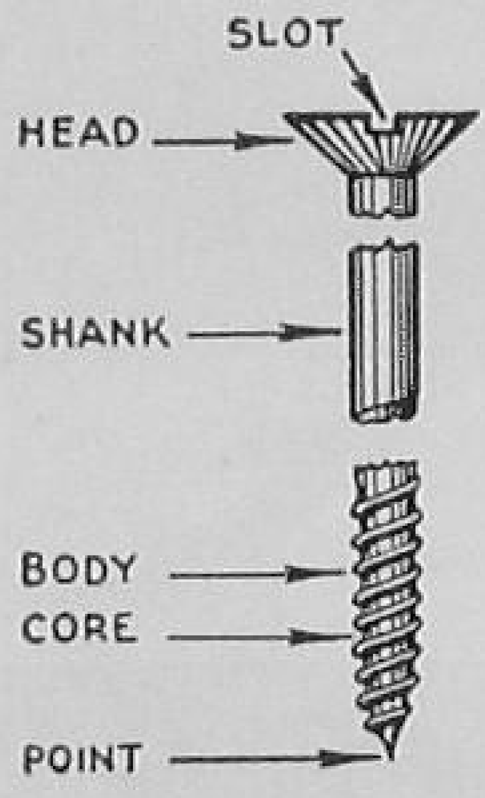


Fig. 47. Parts of screw.

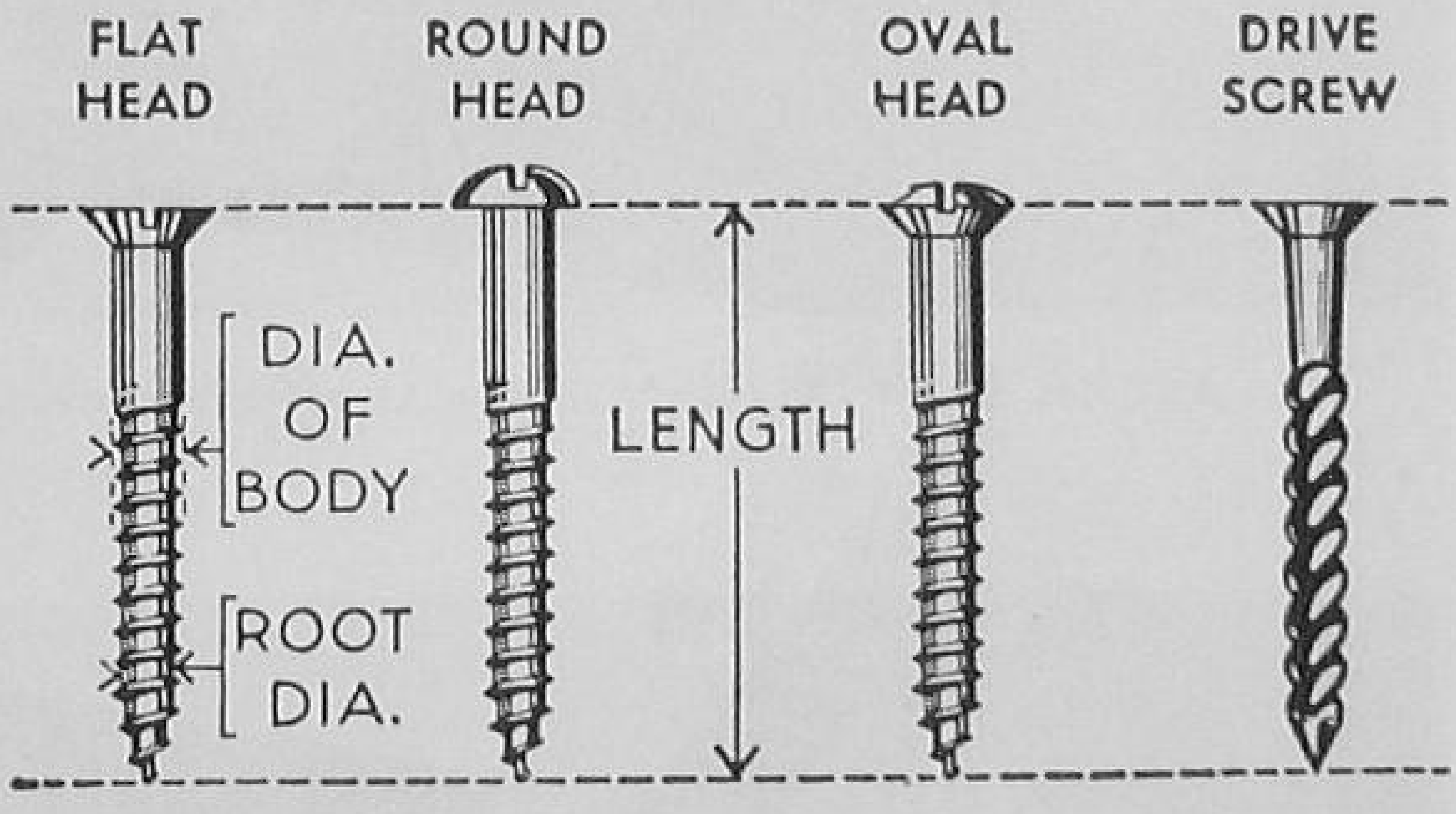


Fig. 48. Types of wood screws.

The parts of the screw as indicated by the diagram (Fig. 47) are the slot, head, shank, body, core, and point. When choosing a wood screw, three factors should be considered: First, the length of the screw, determined by the thickness of the materials to be joined. Second, the diameter of the screw, determined by the kind of material and the strength of joint needed. Third, the type of screw head, determined by finish of the surface in which the screw is used (see Fig. 48).

In fastening the two pieces together, it is first necessary to drill a small hole in each piece to prevent the screw from splitting the wood. The bottom piece has the center located on one surface, where the two diagonal lines cross each other. At this point, using a drill stock and a twist drill (Fig. 49), drill a hole through the piece. The twist drill should be as large as, or slightly larger than, the shank, or straight part, of the screw. Using a countersink (Fig. 50) and bit brace, bore a conical shaped hole in the

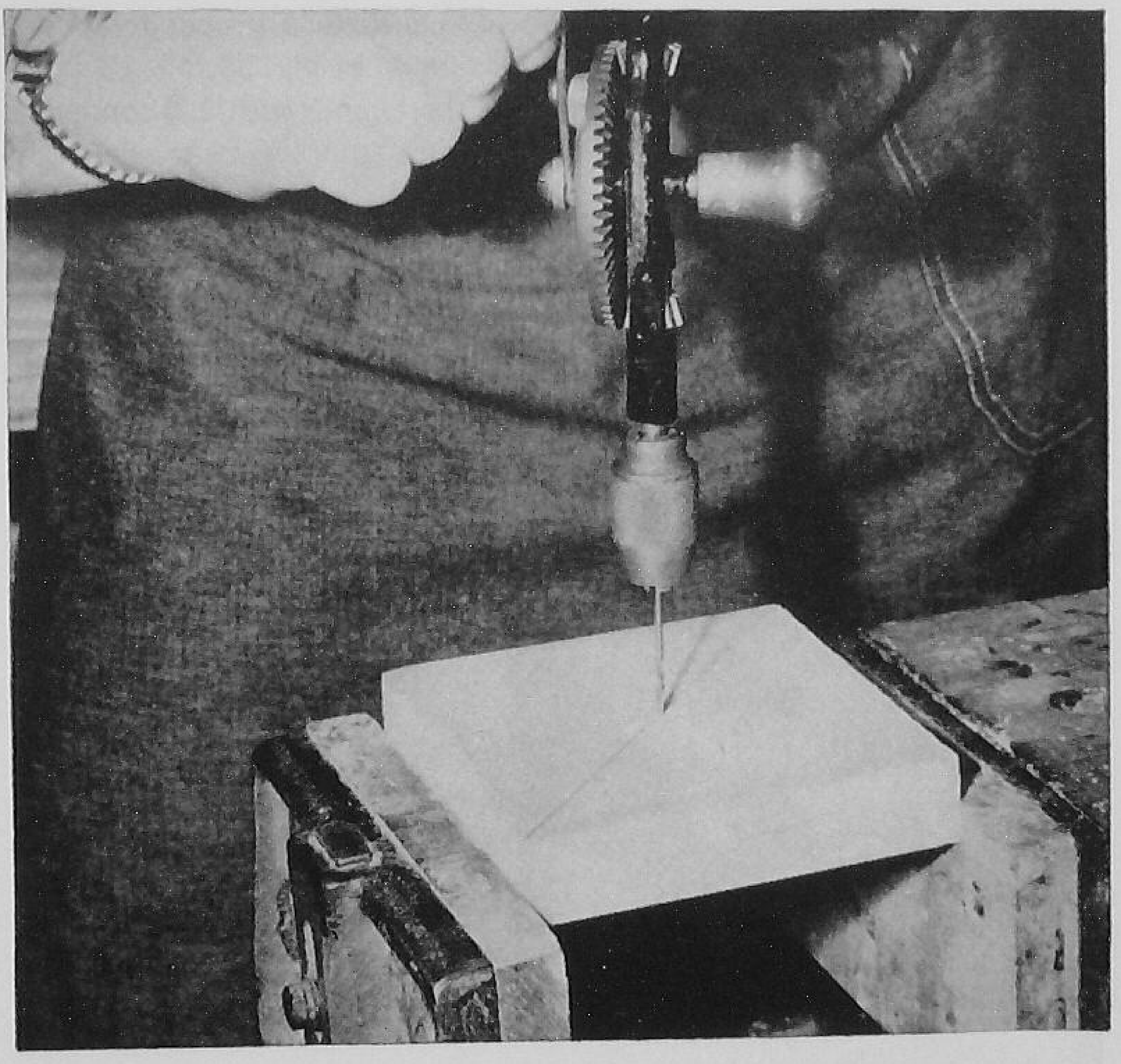


FIG. 49. Drilling a hole for a screw.

hole just drilled (Fig. 51). This hole should be deep enough to accommodate the head of the screw so that it will be flush with the bottom surface of the piece of wood. Next locate the center of the feet of the duck by drawing diagonals across the corners. Where the lines cross, twist a brad-awl into the wood (Fig. 52) to provide a lead, or pilot hole, for the screw. If hardwood is used it will be necessary to make this hole with a twist drill, using a drill slightly smaller than the diameter of the threaded portion of

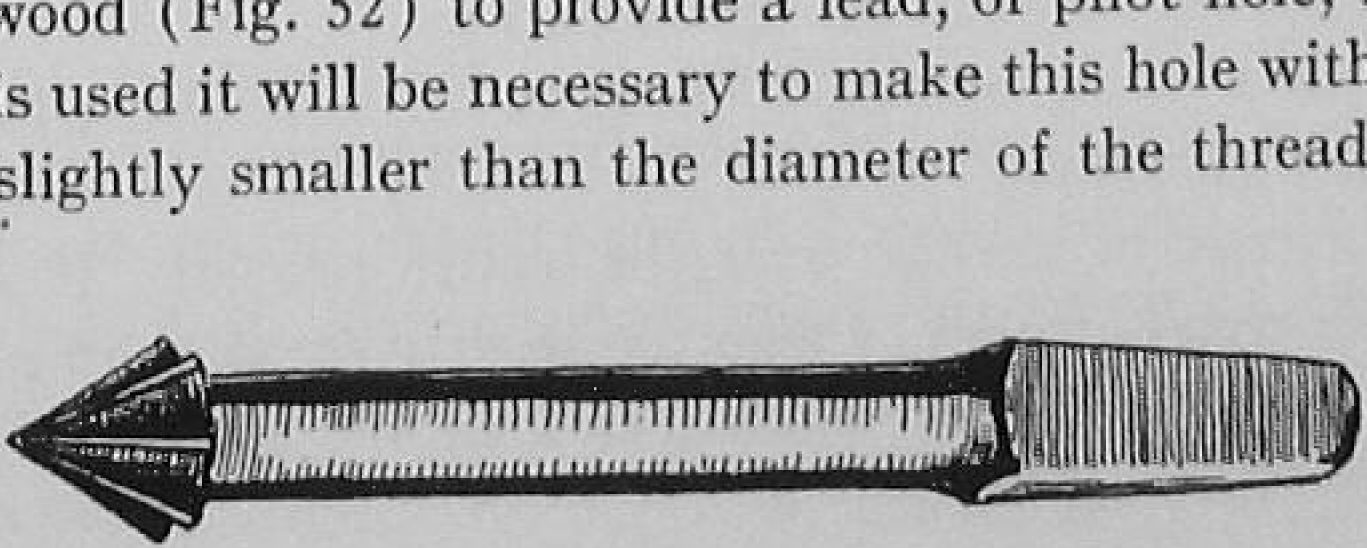


FIG. 50. Countersink.

the screw. When all screw holes have been drilled in proper relation to each other they should appear in cross section as in Fig. 53.

14. Before assembling, sand both pieces thoroughly with 2/0 sandpaper, then with 4/0 sandpaper. Care should be taken to prevent the edges from becoming rounded.

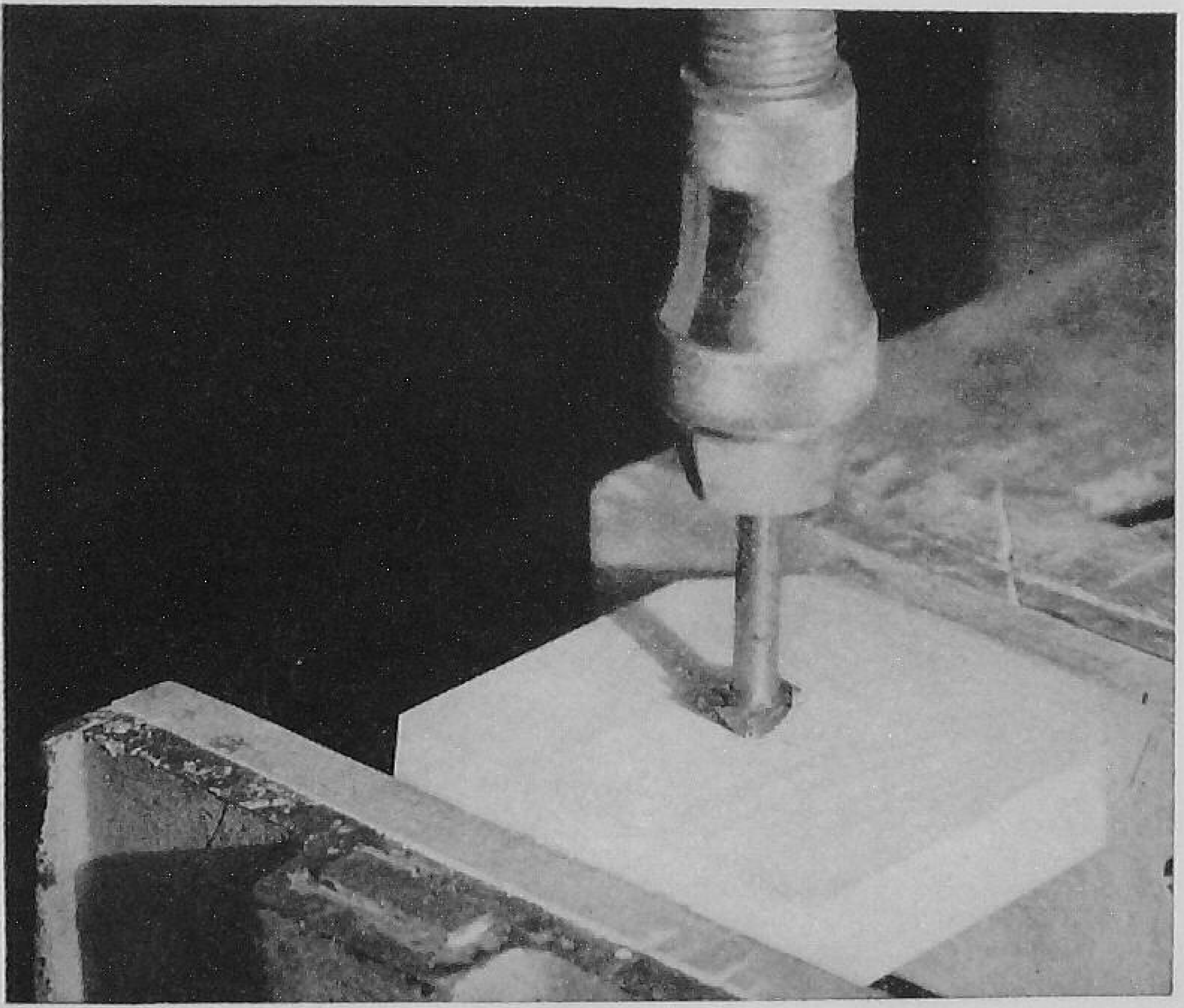


FIG. 51. Using a countersink.

15. Using a screw driver (the size to fit properly in the screw slot), fasten the two pieces together as shown in Fig. 54.

16. Glue a piece of 3/8″ dowel, 1″ long, in the hole bored for the thimble holder, using a liquid glue.

17. Apply a coat of shellac over the entire project. If shellac is too thick, thin with wood alcohol. Clean the shellac brush with alcohol.

18. After the shellac is dry, smooth it with 4/0 sandpaper, or fine steel wool; then dust thoroughly.

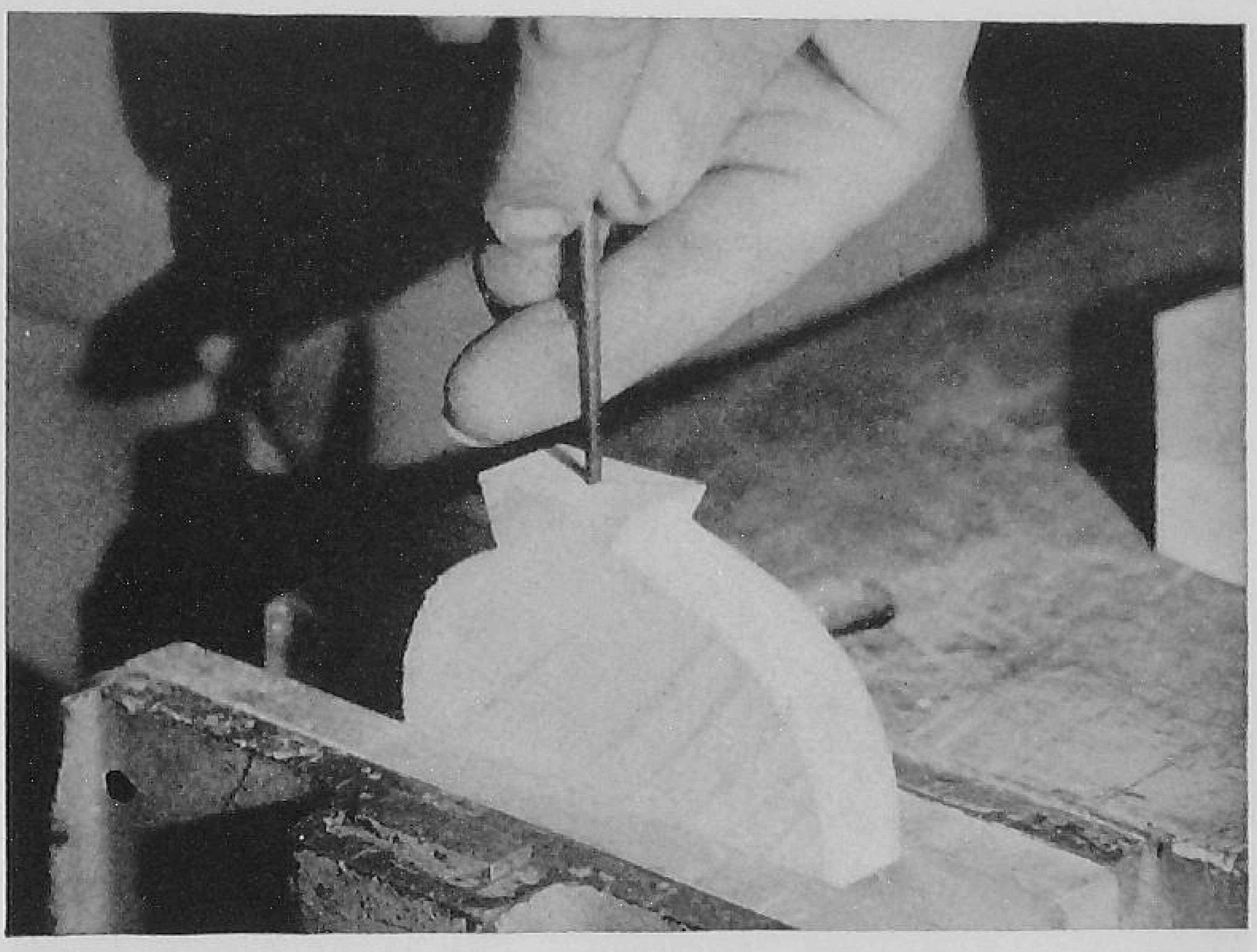


FIG. 52. Starting a hole with a brad awl.

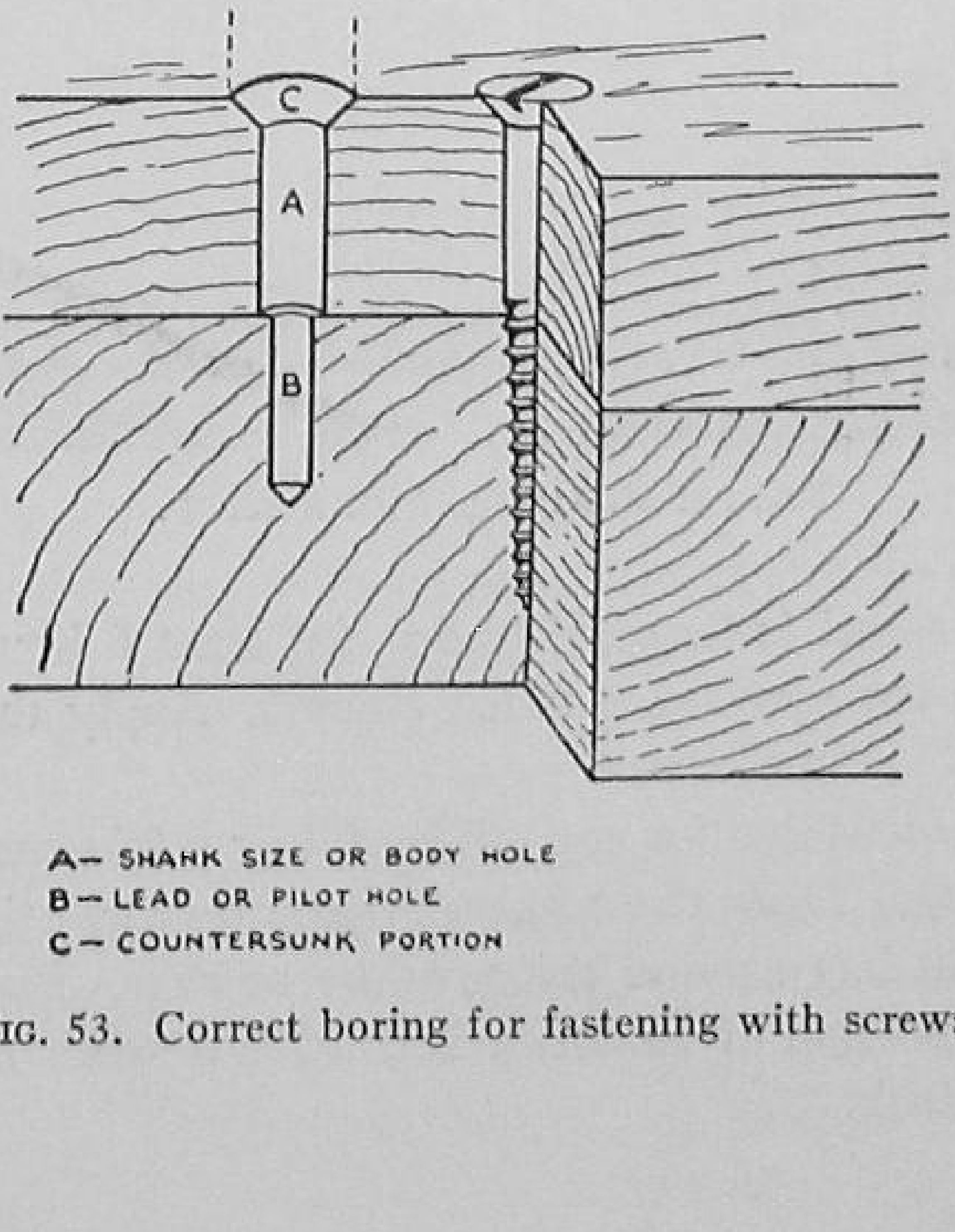


FIG. 53. Correct boring for fastening with screws.

19. Apply a coat of colored enamel, using any color or combination of colors desired. The duck shown in Fig. 34 was given a coat of red enamel on the base and yellow enamel on the body. Clean the paint brush with turpentine.

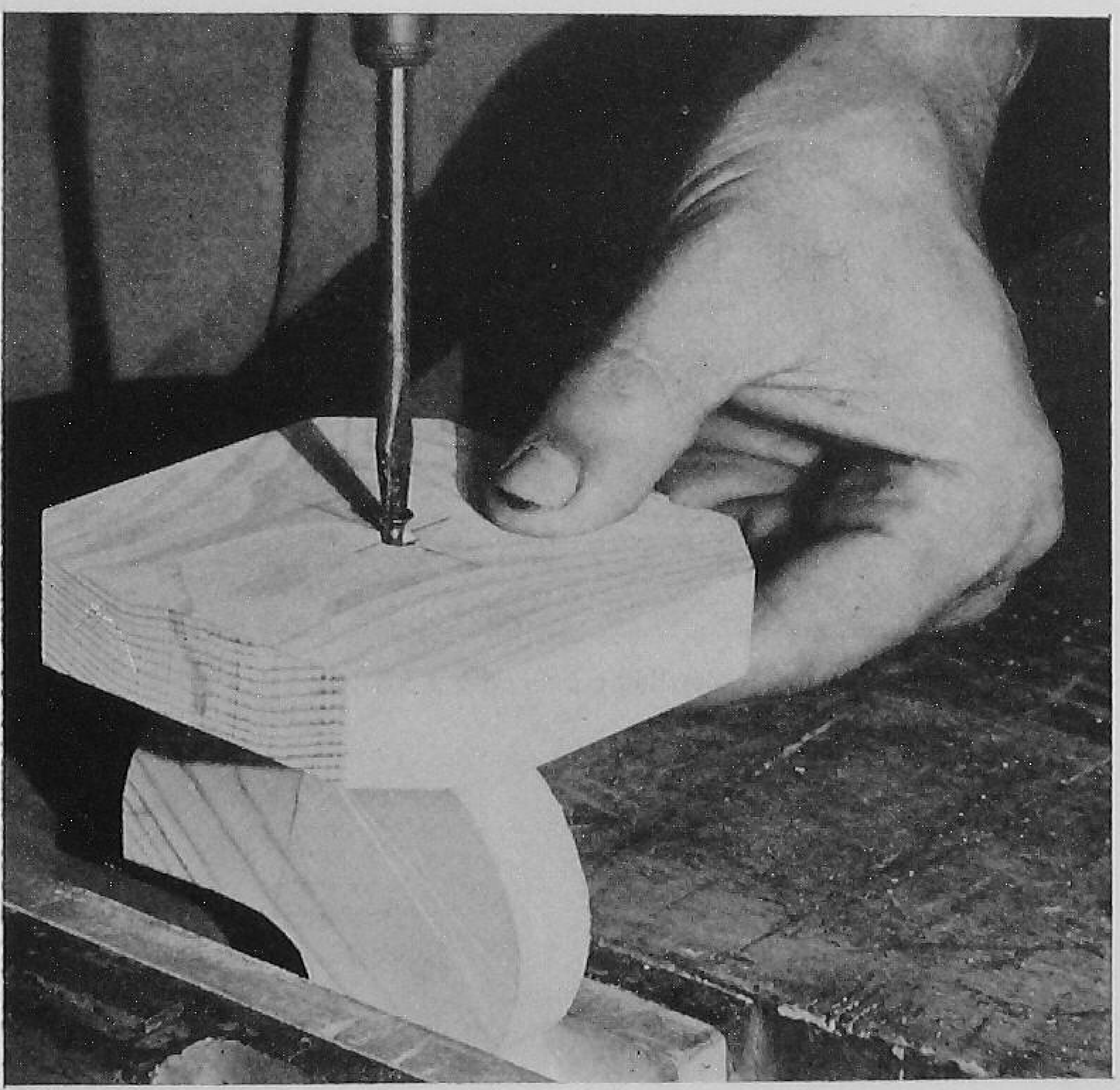


FIG. 54. Fastening with a screw.

20. After the enamel is thoroughly dry (at least 6 hours), paint in the wing outlines and the eyes using black enamel. Apply the enamel with a fine artist's brush.

21. Make the pincushion for the tail by filling a 2″ square piece of cloth with sawdust or rags. Draw the corners up and tie them tightly so that the cloth forms a tight bag around the sawdust or rags. Place the tied part down on the tail portion of the duck and drive a small brad through the bag and into the duck.

22. Drive four $1\frac{1}{4}''$, No. 16 brads into the base as shown in the working drawing. These are spaced two on each side and serve as holders for spools of thread.

Necktie Rack

1. On a piece of stiff paper, lay out the pattern for the base of the necktie rack by drawing the 1″ squares as shown. Cut out the pattern with scissors.

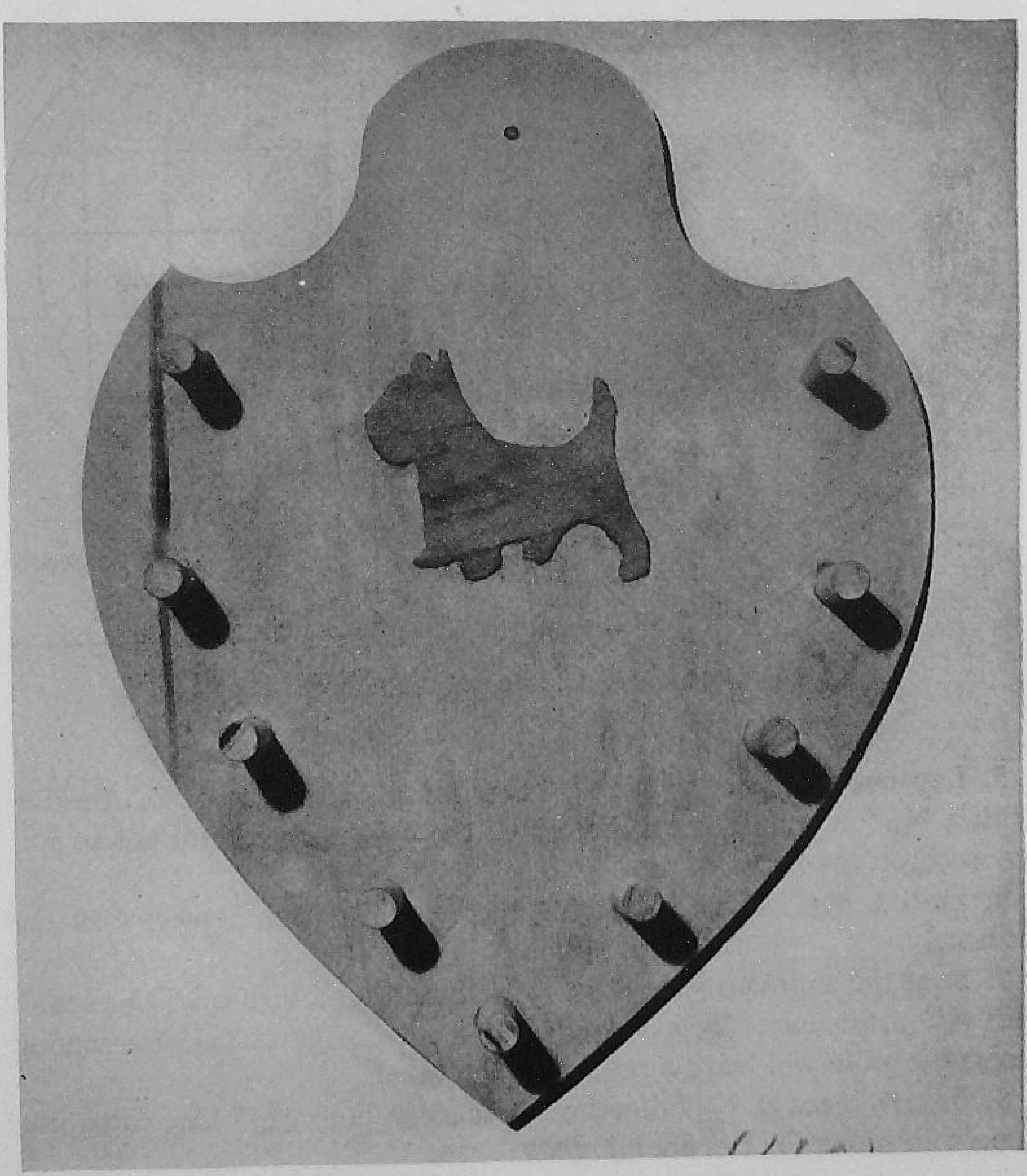


FIG. 55. The necktie rack.

2. Trace the pattern on a piece of ¼″ plywood that is approximately 8½″ wide and 9″ long. The grain of the wood should run lengthwise to the piece.

3. Using a coping saw, cut out the design. Saw just outside the lines.

4. With a half-round woodworker's file smooth all edges. Be sure to keep edges square.

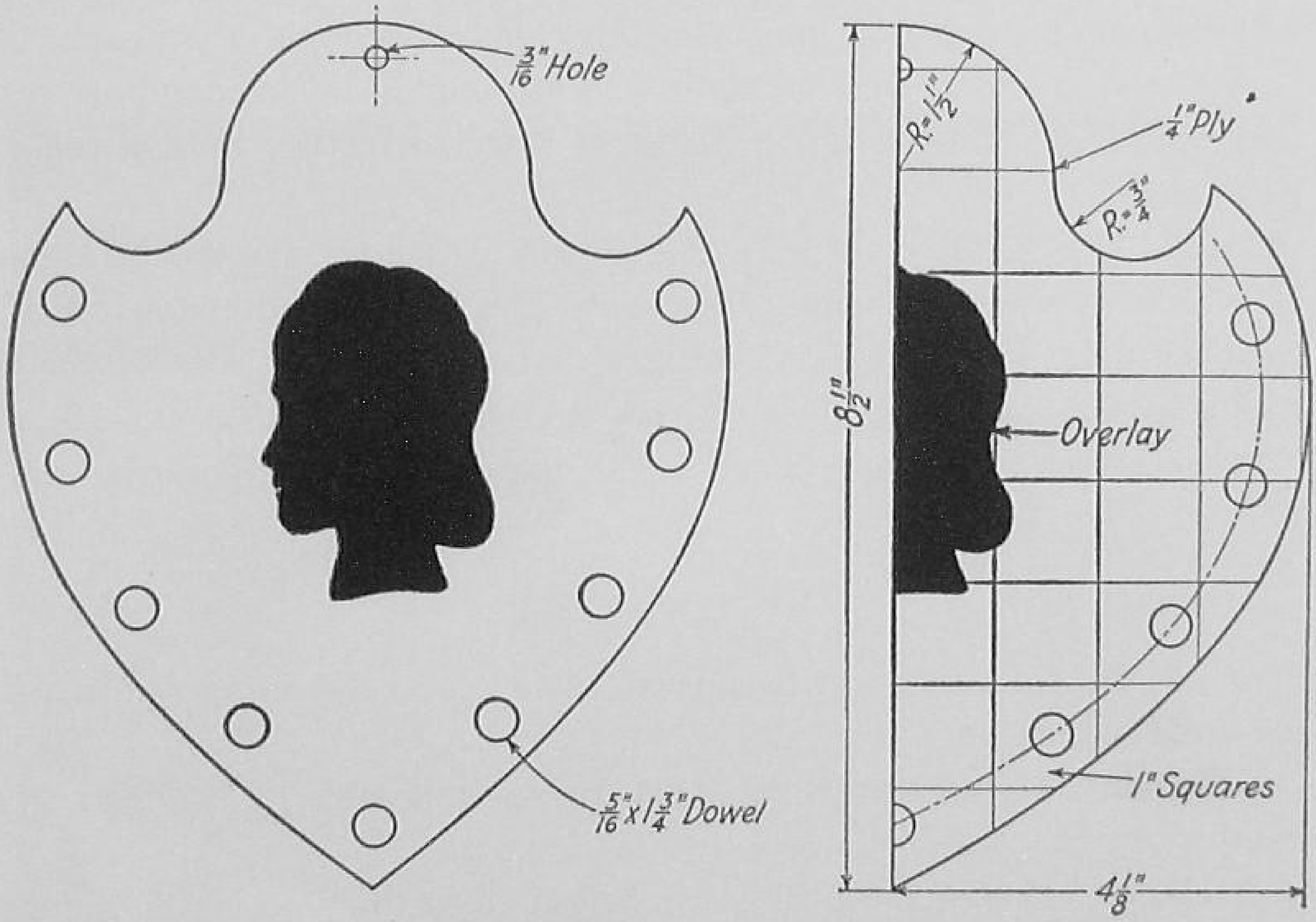


Fig. 56. Drawing of the tie rack.

5. Lay out position for boring holes for pegs, as shown in drawing. With a $\frac{5}{16}$″ auger bit and a brace bore the holes. Be careful not to split the wood on the back.

6. Drill a $\frac{3}{16}$″ hole for hanging the tie rack. Use a twist drill and drillstock.

7. Sand the entire project with 2/0 sandpaper, and then sand thoroughly with 4/0 sandpaper. Be sure and sand with the grain because sanding across the grain will leave scratches in the wood.

8. From a piece of $\frac{5}{16}$″ dowel rod, cut nine pieces 1¾″ long to be used as pegs on which the ties are hung.

9. Glue the pegs in the holes, using a liquid glue.

10. The handicraft worker must now decide on the type of finish and decoration to be used. If a veneered picture has been made, the worker may use one of the cut-out figures left over from making the picture and glue this figure on the surface of the tie rack. A small whittled figure may be made and glued to the surface or a design may be burned in the wood by use of an electric woodburning pencil. After any of these decorations have been applied, cover the entire surface with three coats of shellac. Allow each coat to dry for approximately 6 hours, rubbing down each coat with fine steel wool. Dust carefully and thoroughly before applying each coat of shellac. After rubbing down the last coat, apply a light coat of paste wax.

11. Another suitable finish for this project is to apply one coat of shellac and, when dry, rub with fine steel wool. Apply a coat of enamel of any color desired. When this is thoroughly dry, apply to the front of the tie rack a decalcomania, or transfer, which may be obtained in a 5 and 10 cent store. Directions for applying are on the back of the decalcomania.

Doorstop (Dog)

1. Lay out the pattern using squares as shown in the drawing; then cut the design as shown in Fig. 59.
2. With rubber cement, cement the design on a piece of ¼″ thick plywood approximately 4½″ wide and 7½″ long.
3. Using a coping saw, cut out the design along the lines of the pattern.
4. With a half-round woodworker's file, smooth all edges.
5. Lay out the pattern for the base as shown in the drawing and cut out the pattern with scissors.
6. With rubber cement, cement the pattern on a piece of pine or basswood approximately ¾″ thick, 2″ wide and 4½″ long.
7. Cut along the pattern lines with a coping saw.
8. Smooth with a half-round wood file.
9. Lay out the holes for screws on the bottom of the dog, as shown in the drawing.
10. With a ⅛″ drill, drill two holes for the screws.
11. Countersink the holes on the front of the dog.
12. With a bradawl, locate and make the holes for the screws in the base piece.

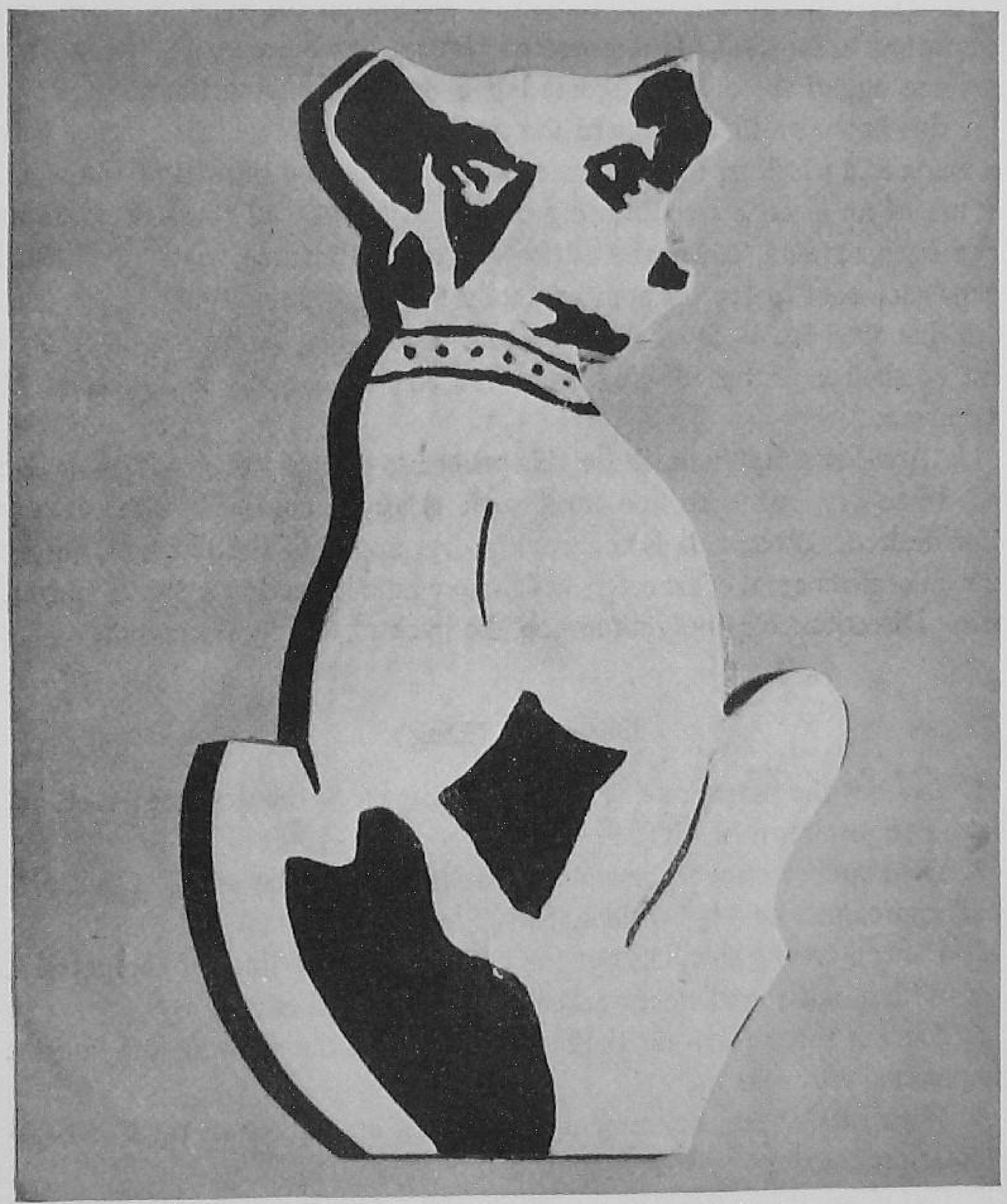


FIG. 57. The dog doorstop.

13. Smooth all surfaces and edges of both pieces with 2/0 sandpaper. Give a final sanding with 4/0 sandpaper.

14. Assemble with two 1″, No. 8 flathead wood screws.

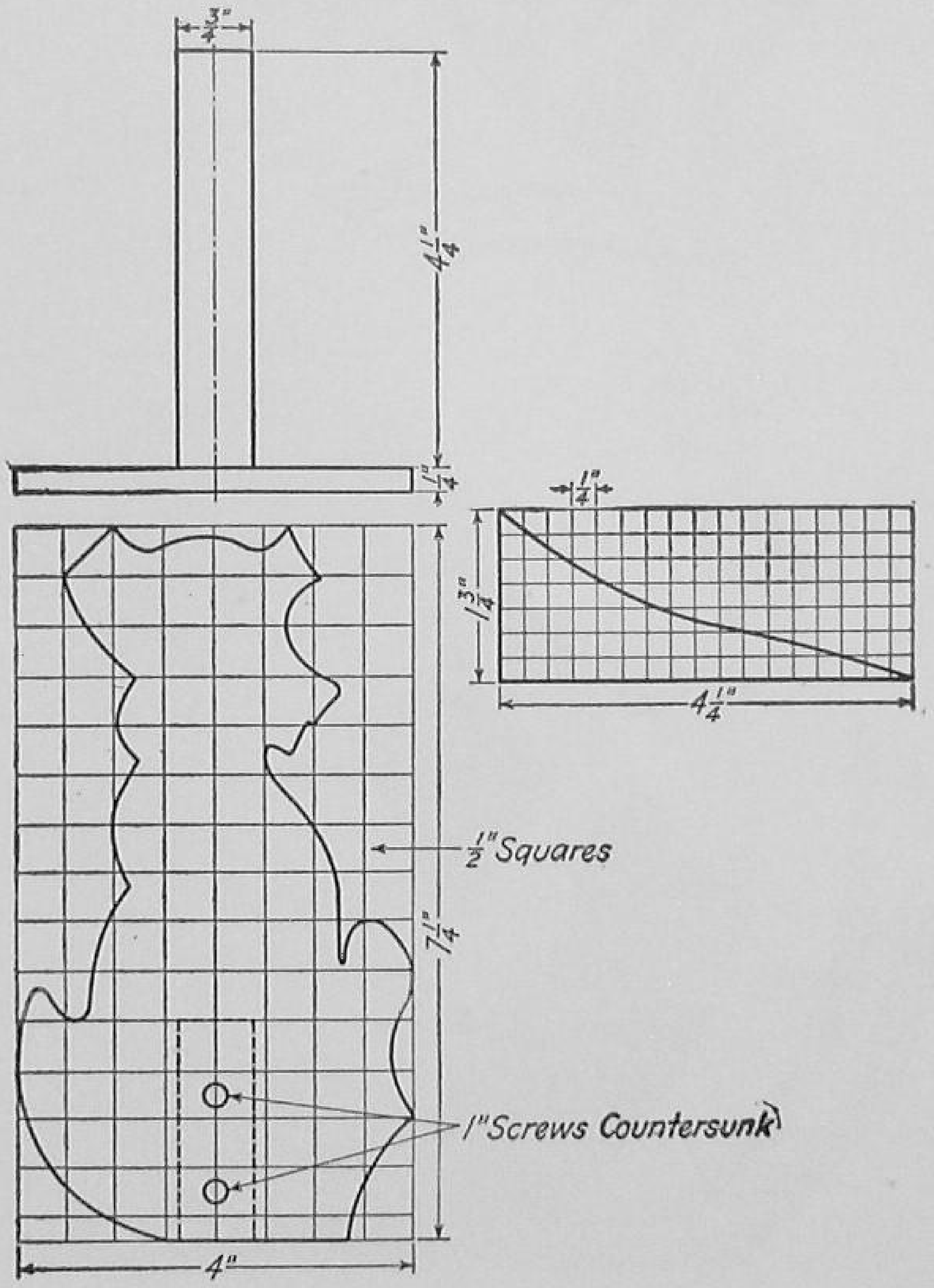


FIG. 58. Drawing of dog doorstop.

15. Give entire job a coat of shellac and, when thoroughly dry, rub with fine steel wool.

16. Dust the job thoroughly and apply a coat of white enamel.

17. When dry, apply black enamel on places indicated in the drawing. Clean shellac brush with alcohol and enamel brushes with turpentine.

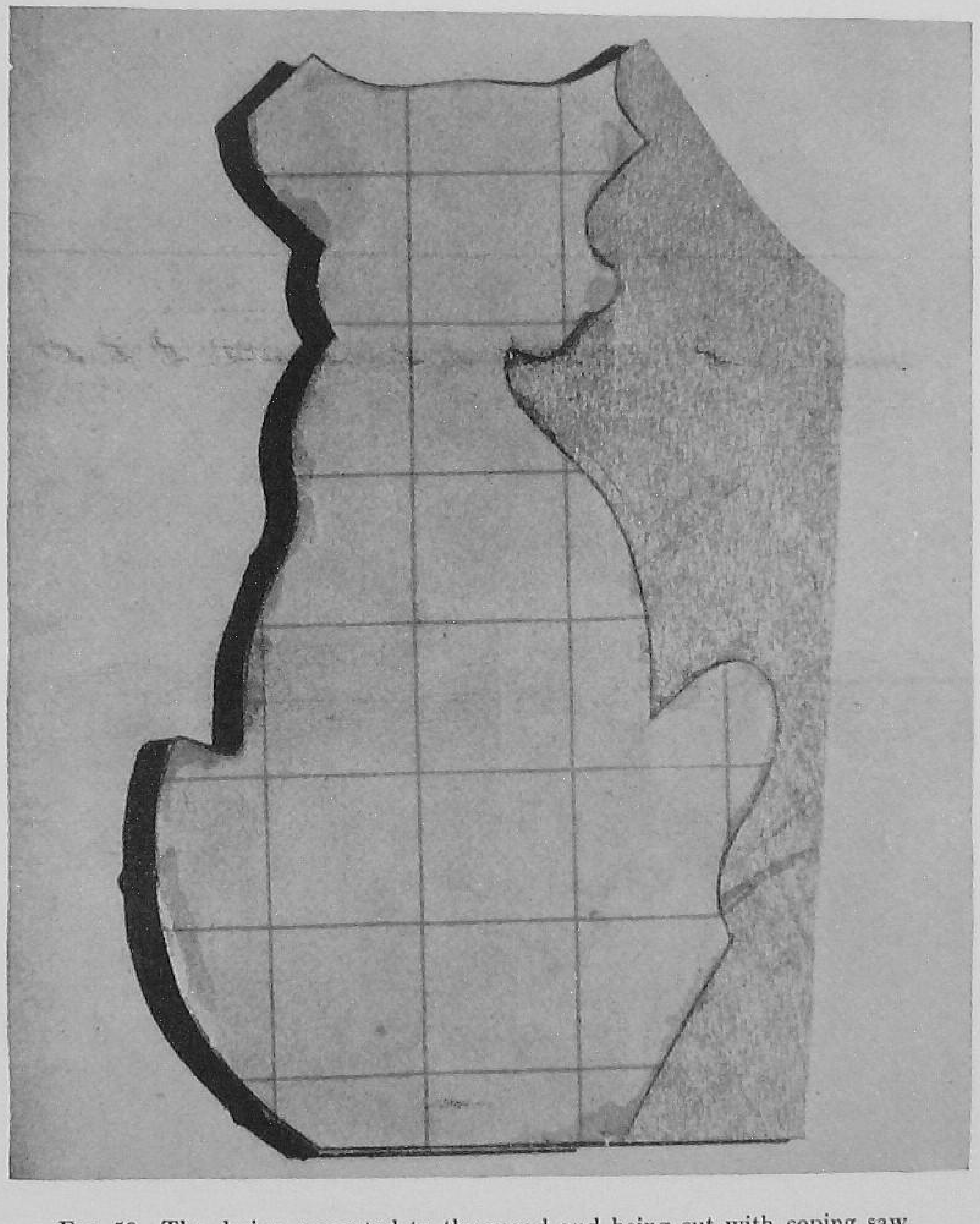


Fig. 59. The design cemented to the wood and being cut with coping saw.

Wall Shelf

1. Obtain a piece of wood ½″ thick, approximately 9″ wide and 9″ long to be used for the back.

2. On a piece of cardboard, lay out the design as shown in the drawing, using 1″ squares.

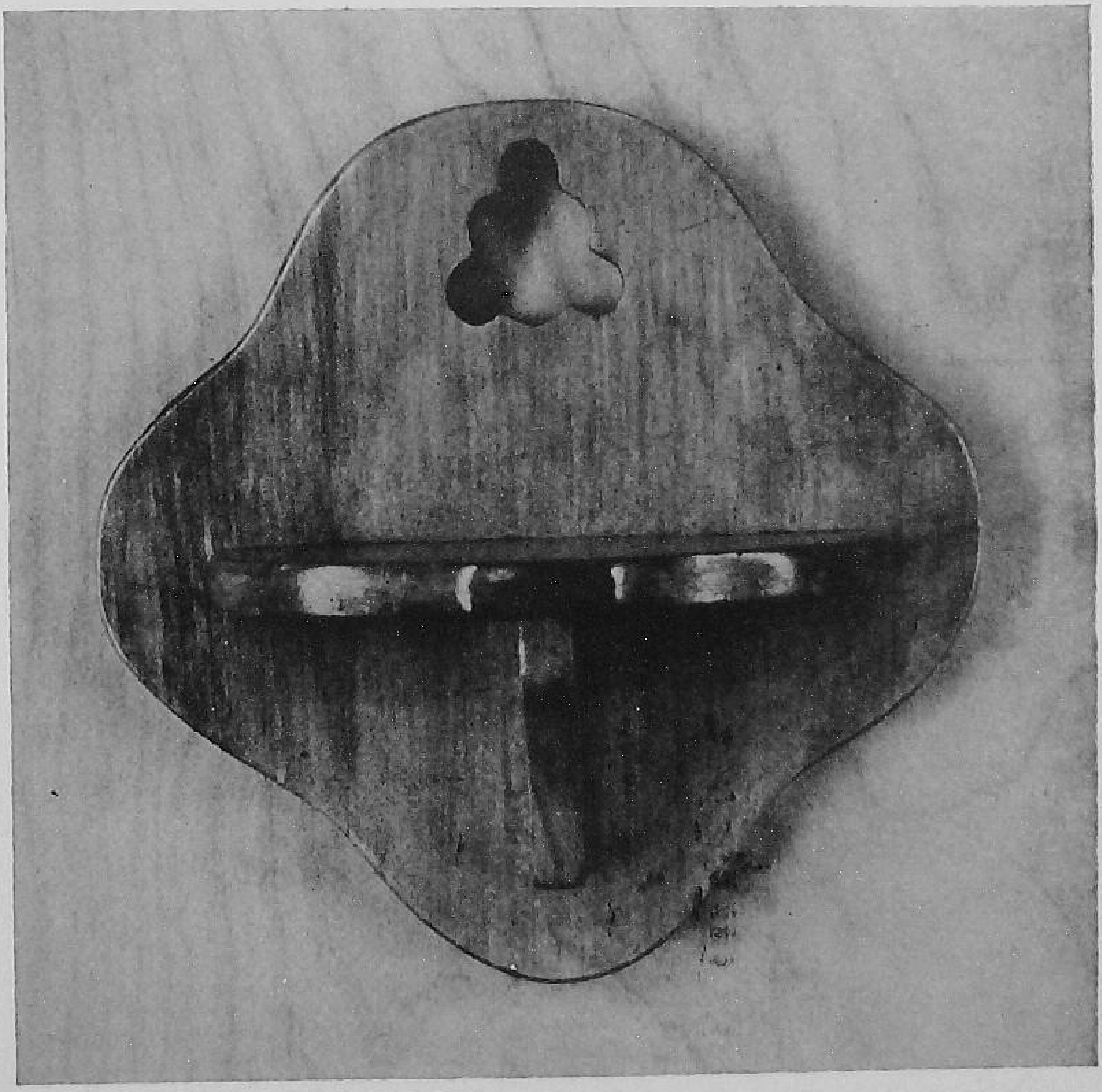


FIG. 60. The wall shelf.

3. Cut out the pattern with scissors and trace the design on the surface of the wood.

4. With a coping saw, cut out the design (Fig. 62) and smooth the edges with a half-round wood file.

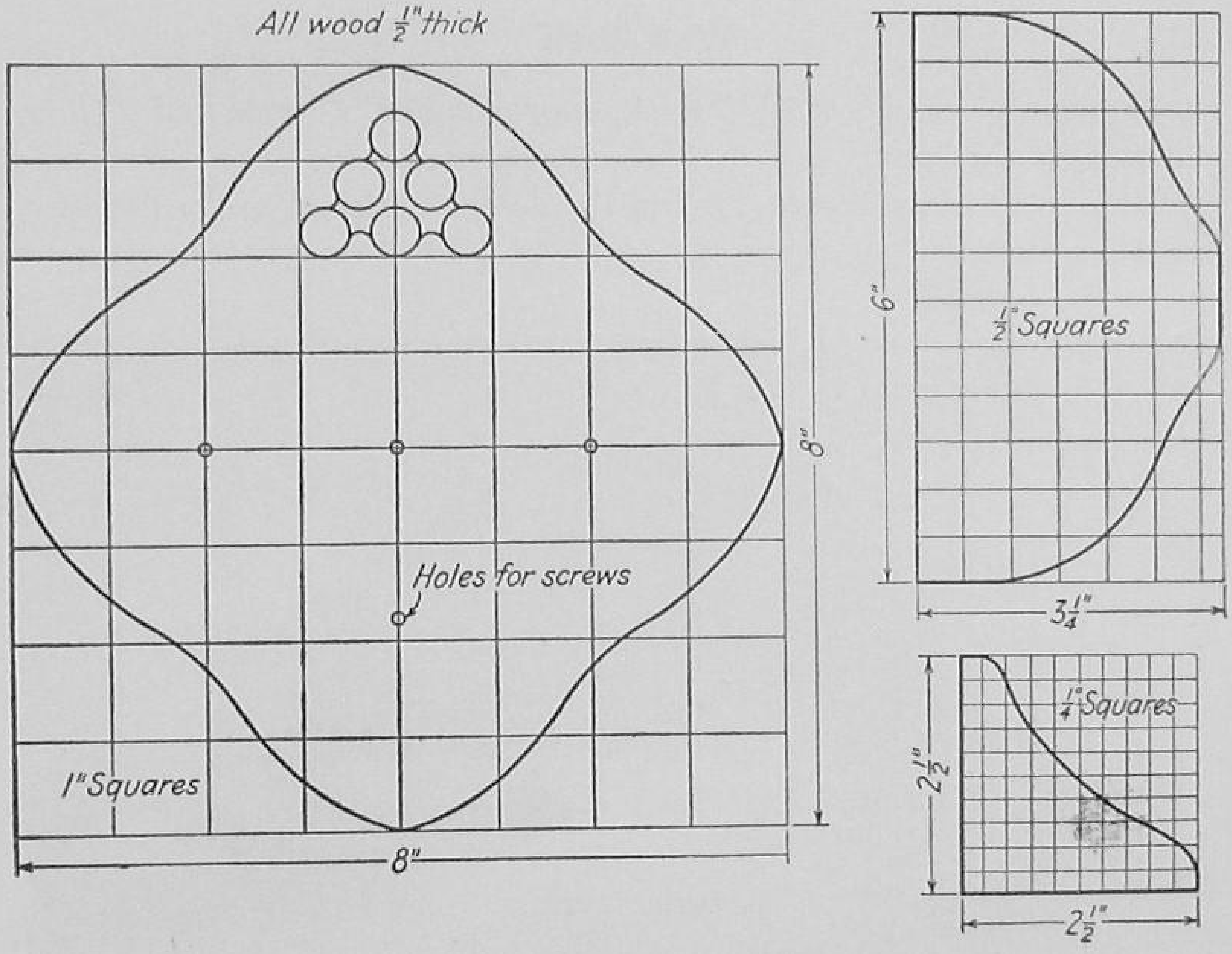


FIG. 61.1. Drawing of the wall shelf.

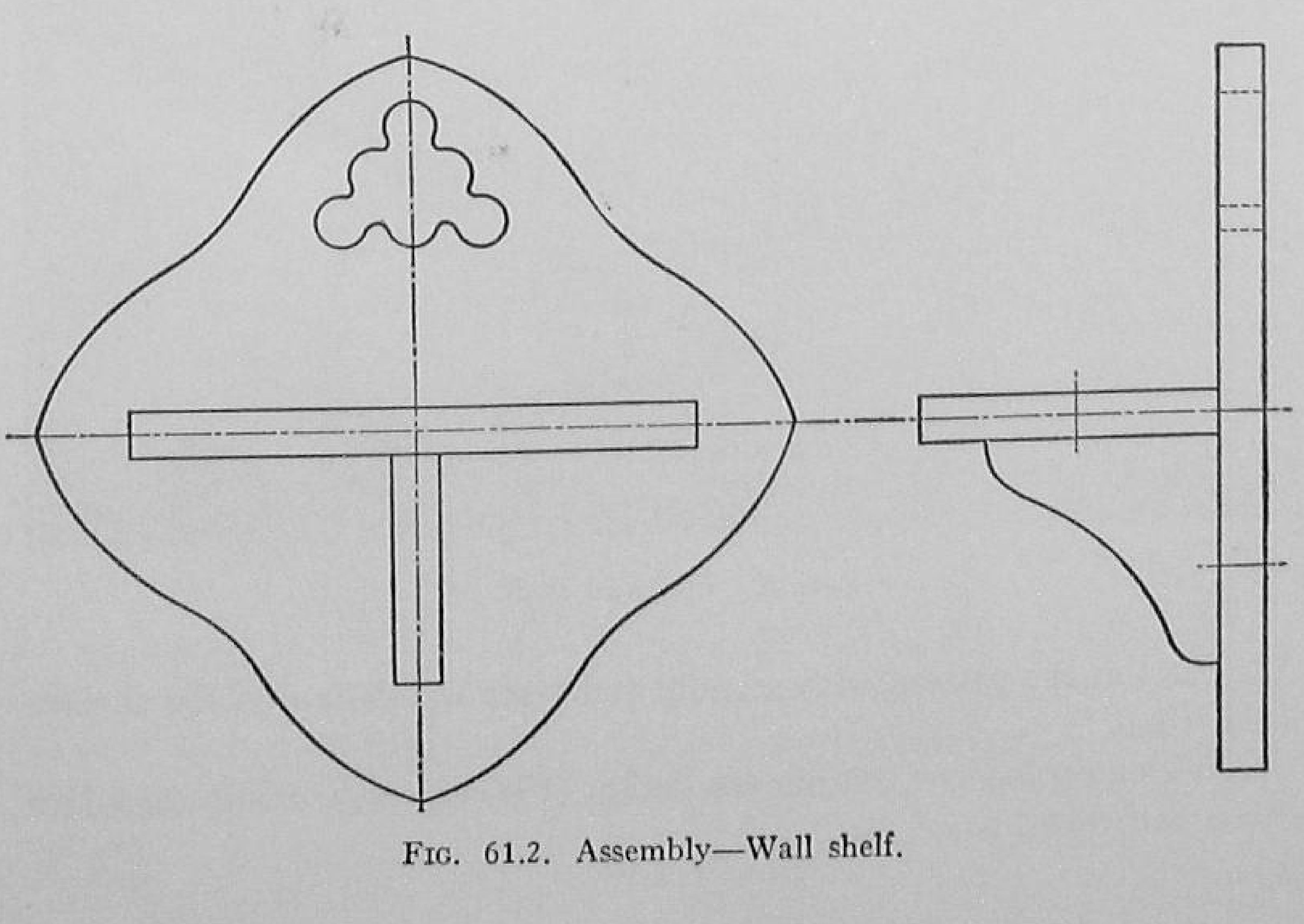


FIG. 61.2. Assembly—Wall shelf.

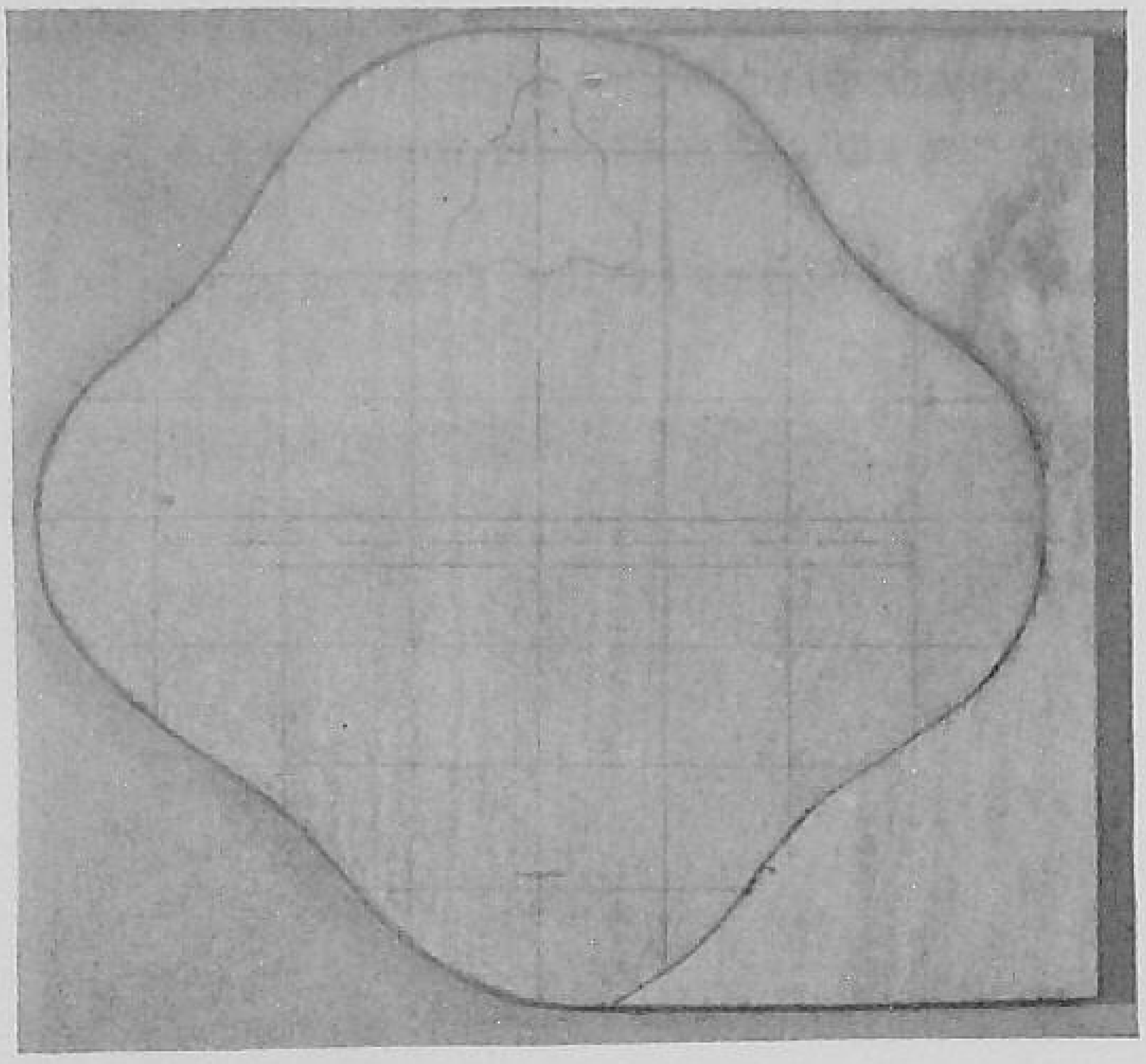


FIG. 62. Cutting out design for back of shelf.

5. In like manner lay out the patterns and cut out the shelf and the brace (Fig. 63).

6. Lay out the holes for the design in the back as shown in the drawing (Fig. 64).

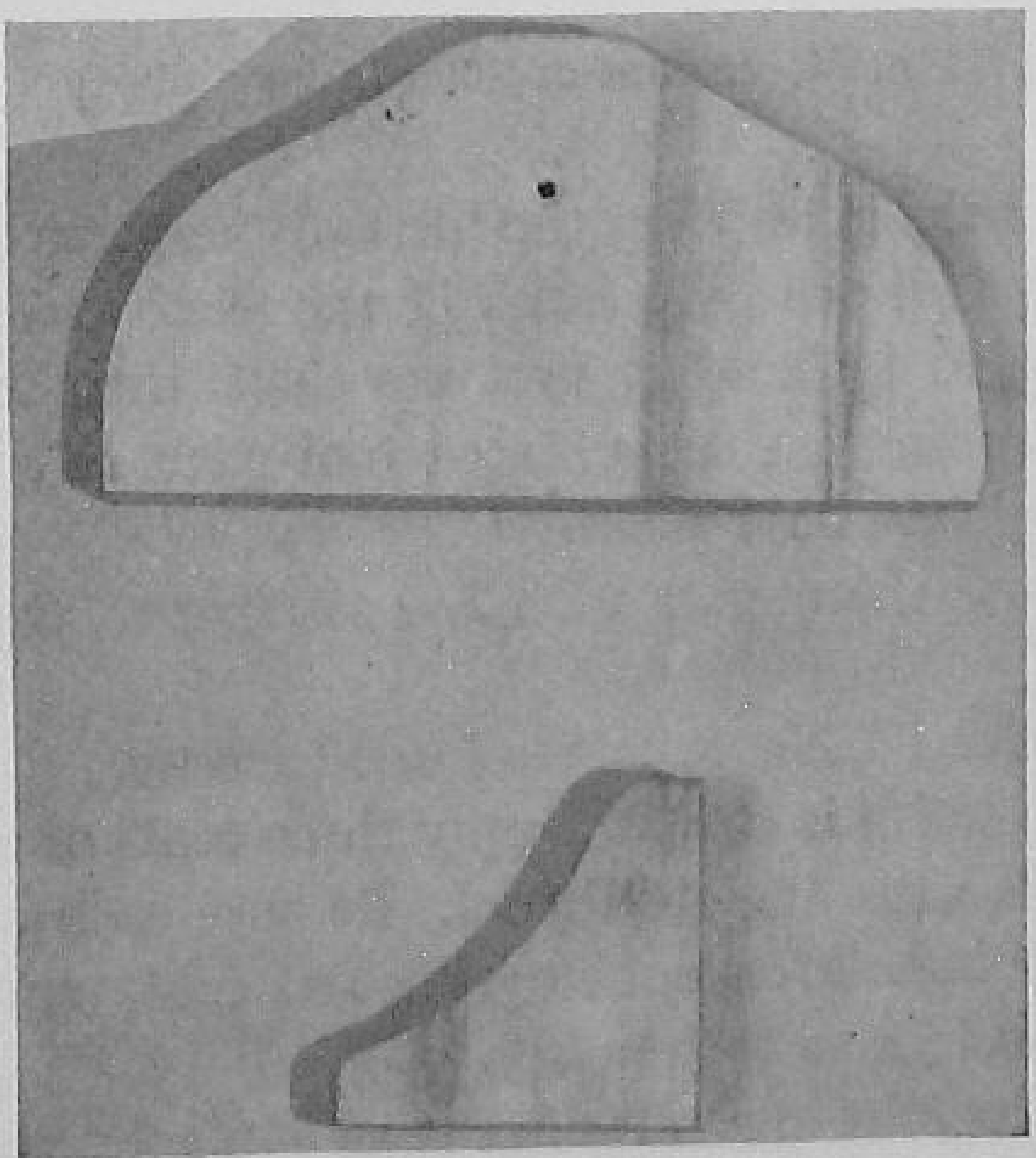


FIG. 63. Shelf and brace.

7. With a ½″ auger bit and brace, bore the holes as shown in the drawing. Care must be taken to prevent splitting the wood.

8. With coping saw cut out remaining wood for the design in the back piece.

9. Lay out and drill the holes for the screws as shown in Fig. 64. Use a ⅛″ drill and drillstock.

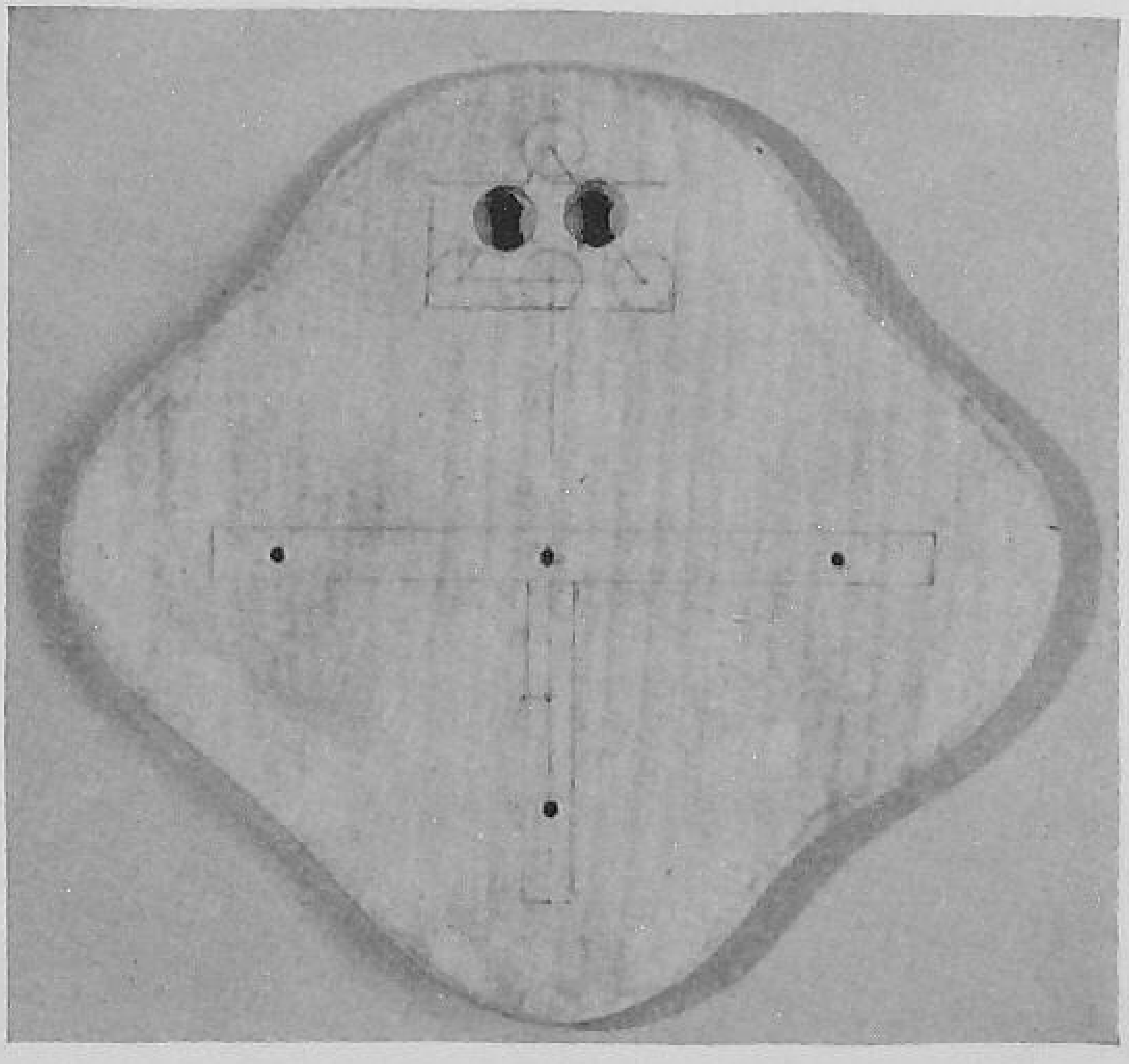


FIG. 64. Layout of holes in back piece.

10. Countersink the holes from the back of the piece of wood.

11. Locate and drill the pilot holes in the shelf and the bracket. The holes may be located by holding first the shelf, then the bracket on the back piece and pushing a sharp-pointed tool such as a bradawl into the holes bored through the back piece.

12. Sand all parts thoroughly with 2/0 sandpaper, then with 4/0 sandpaper.

13. Assemble with 1″, No. 8 flathead wood screws.

14. If a natural finish is desired, apply three coats of white shellac, rubbing between coats with fine steel wool. Be sure each coat is dried thoroughly before rubbing. After rubbing the last coat, apply a light coat of paste wax, and rub to a smooth polish.

15. After the first coat of shellac has been applied a coat of enamel may be applied if a color is desired.

Chapter III

SQUARING STOCK AND ELEMENTARY JOINERY

The projects in this chapter will require that the stock, or wood, be squared by the use of hand tools. The squaring process is accomplished using various tools. These operations should be performed in a definite sequence in order that each part of the project will be squared to exact dimensions. It is extremely important that each part be square and to the required size so that each part will fit properly into place. The squaring process is described in detail in the first project. The other projects in this chapter require practically the same operations but the worker will refer back to the instructions in "the tray" project.

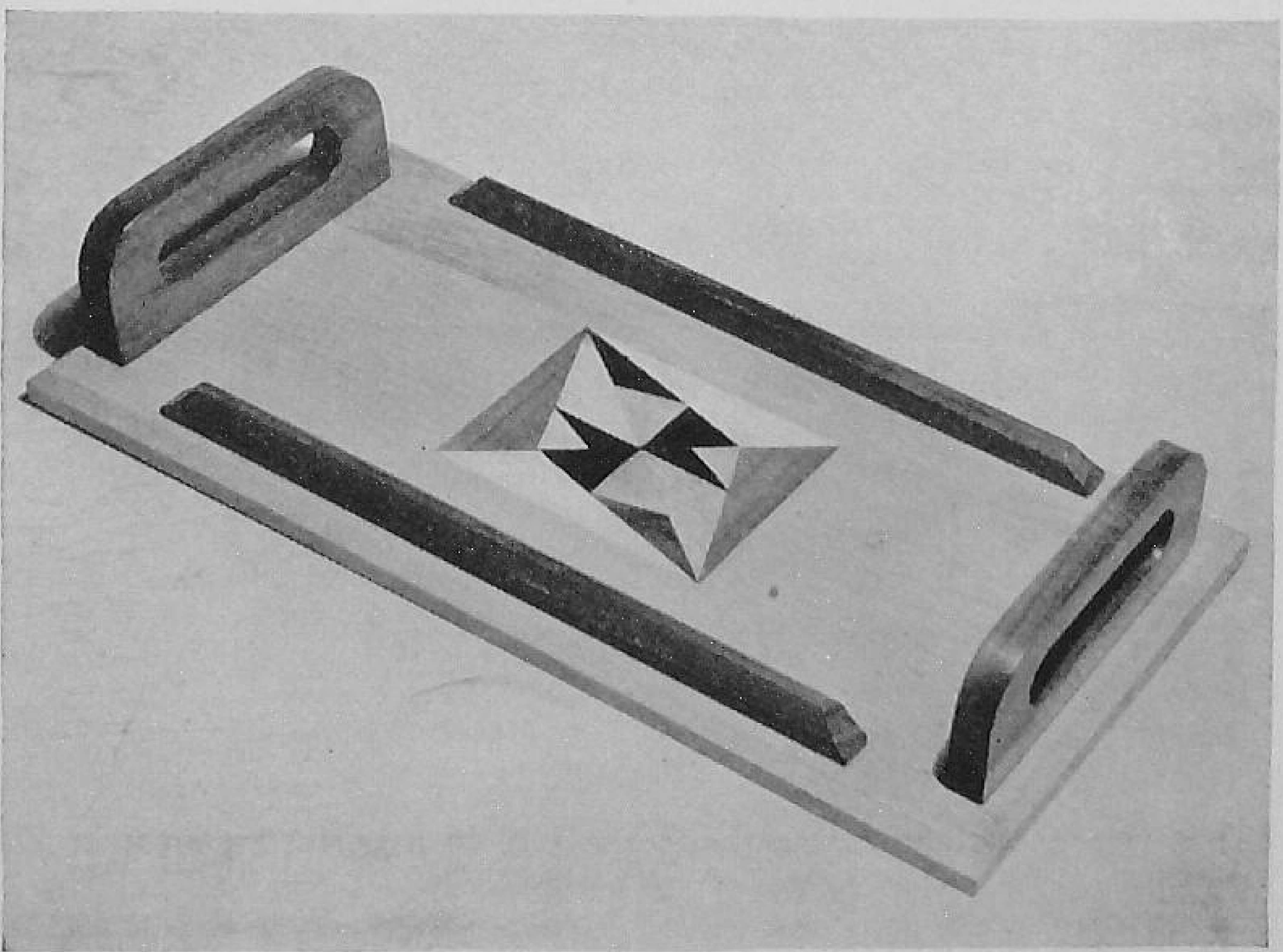


FIG. 65. The tray.

Projects

Tray

1. Obtain a piece of white pine, basswood, or poplar, approximately ⅝″ thick and 7″ or more wide. The first operation is to cut the board, for the

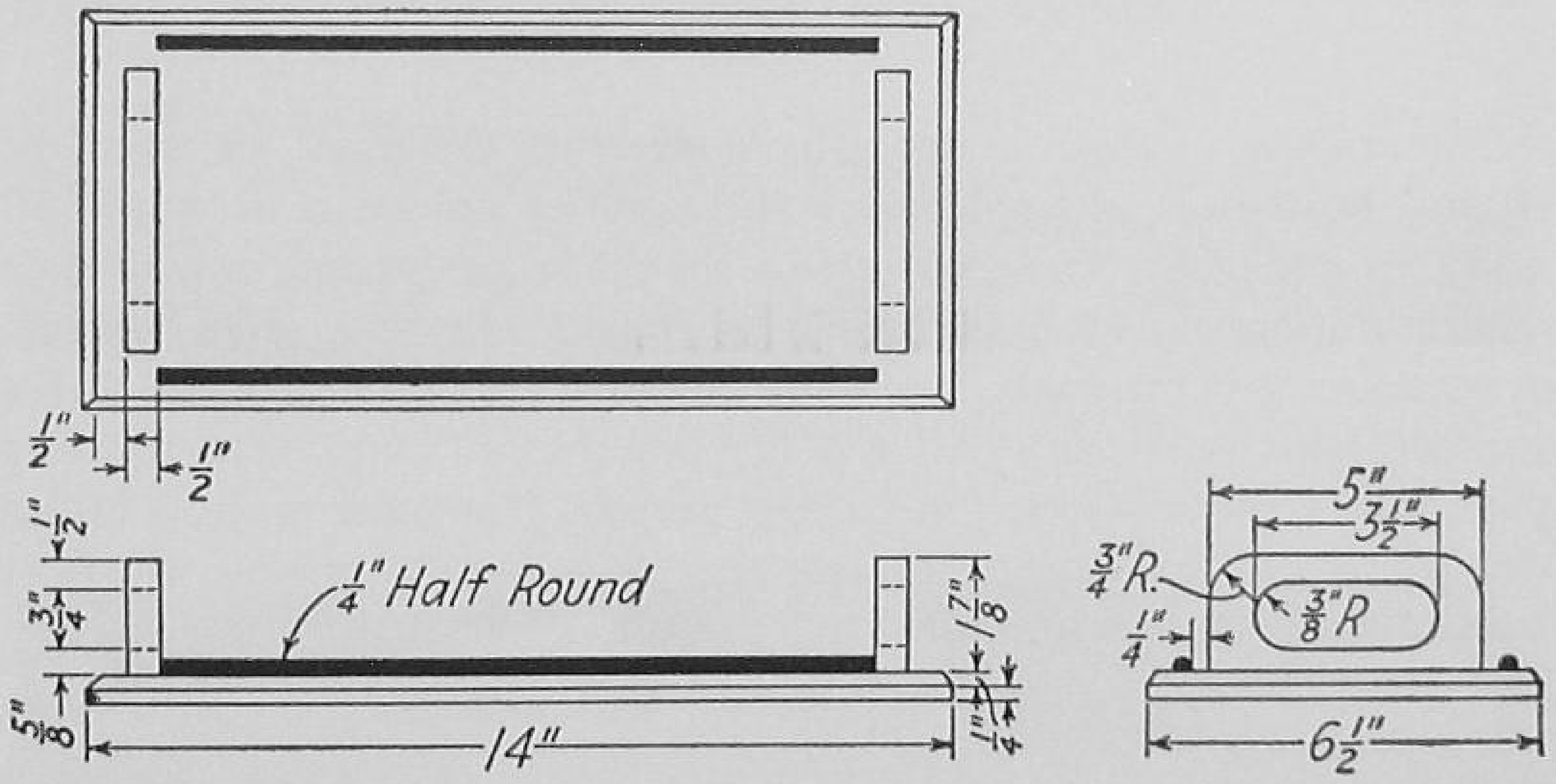


FIG. 66. "Tid-Bit Tray."

base of the tray, to rough dimensions. The tool used for measuring is called a rule. Either a straight 1′ or 2′ rule (Fig. 67) or a one-joint, 2′ rule (Fig.

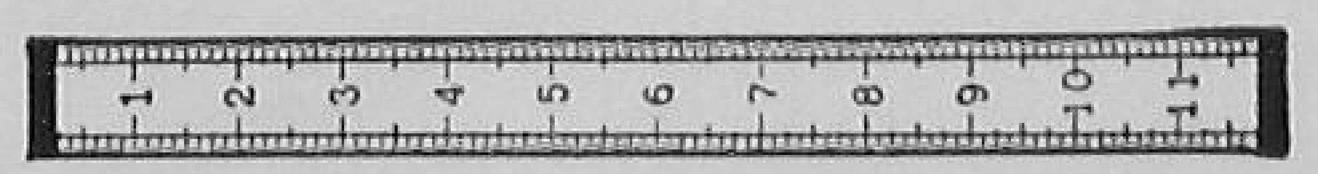


FIG. 67. Straight rule.

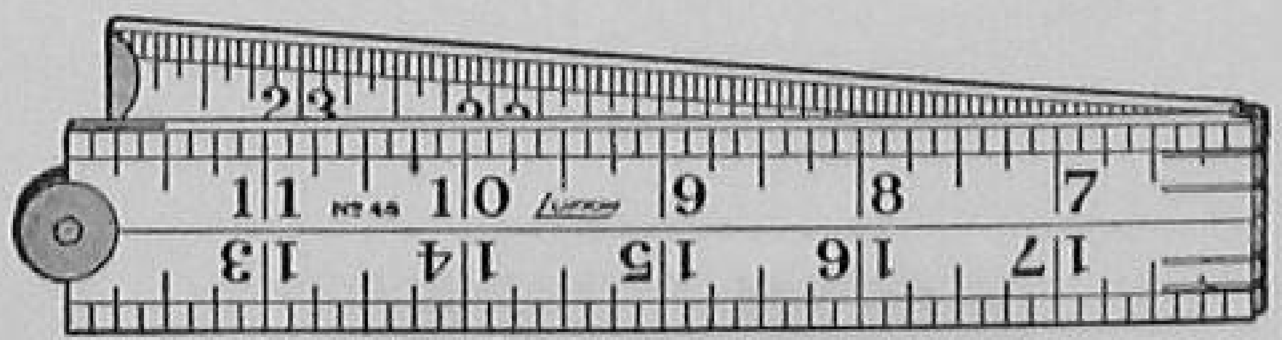


FIG. 68. One-joint, 2′ rule.

68) is the most satisfactory. Hold the rule in a position shown in Fig. 69 and mark off a piece of board 15″ long.

2. Holding a try square as shown in Fig. 70, square a line across the surface of the board. There are two types of try squares commonly used

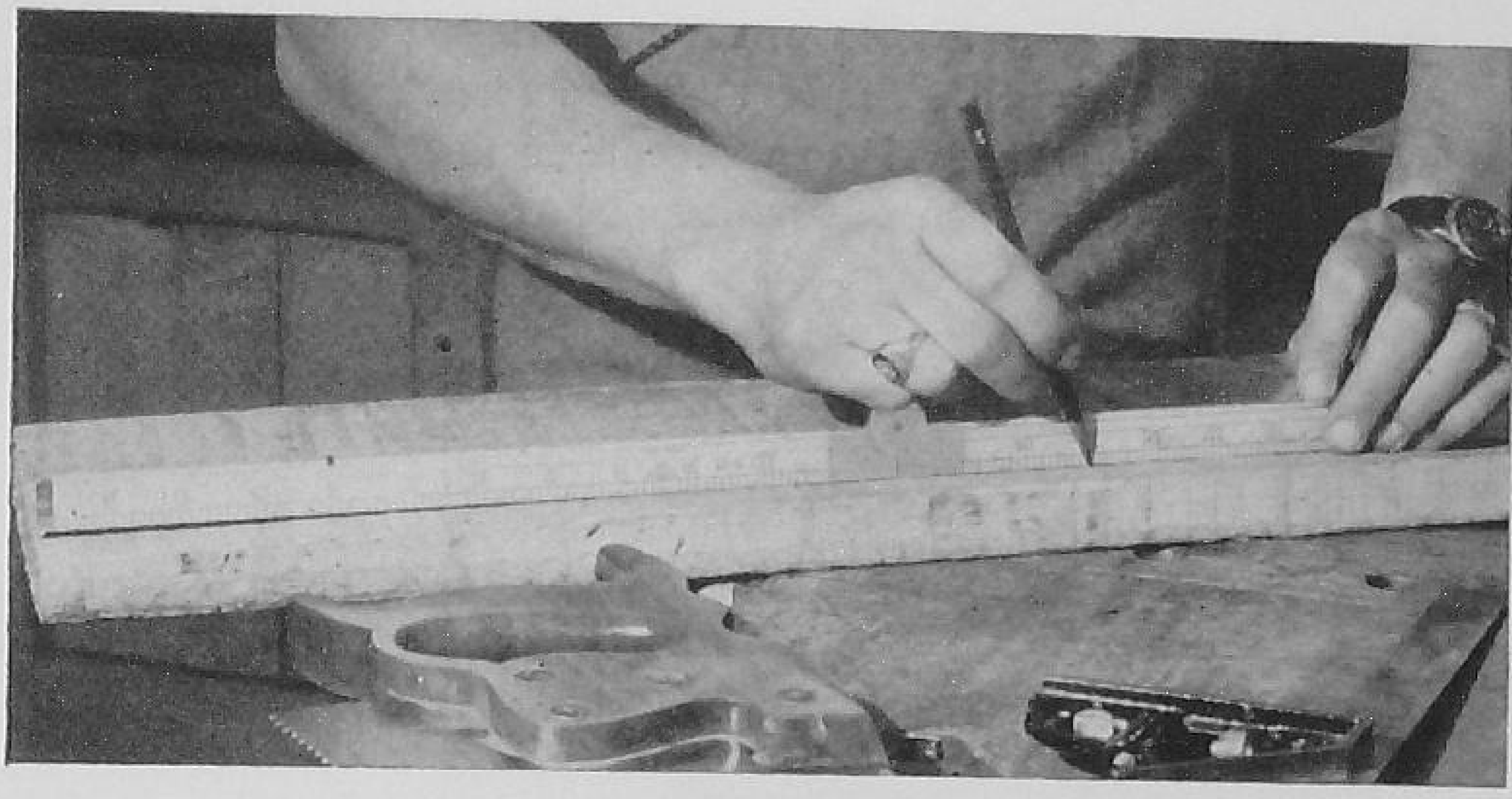


FIG. 69. Measuring the length of a board.

FIG. 70. Using the square as a guide for marking a line across the board.

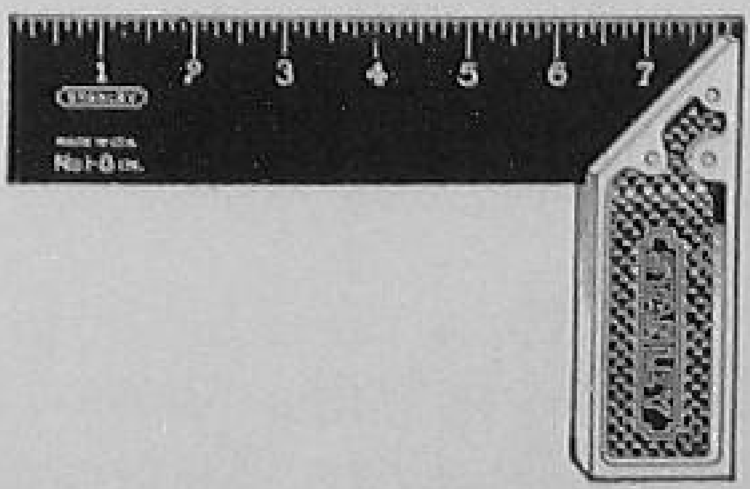


FIG. 71. Try square.

by the woodcraft worker: Fig. 71 which has a handle fastened solidly to the blade and Fig. 72 which is made to allow the handle to slide along the blade and which can be fastened in various places along the blade. Fig. 72, which is called a combination square, has one side of the handle at right

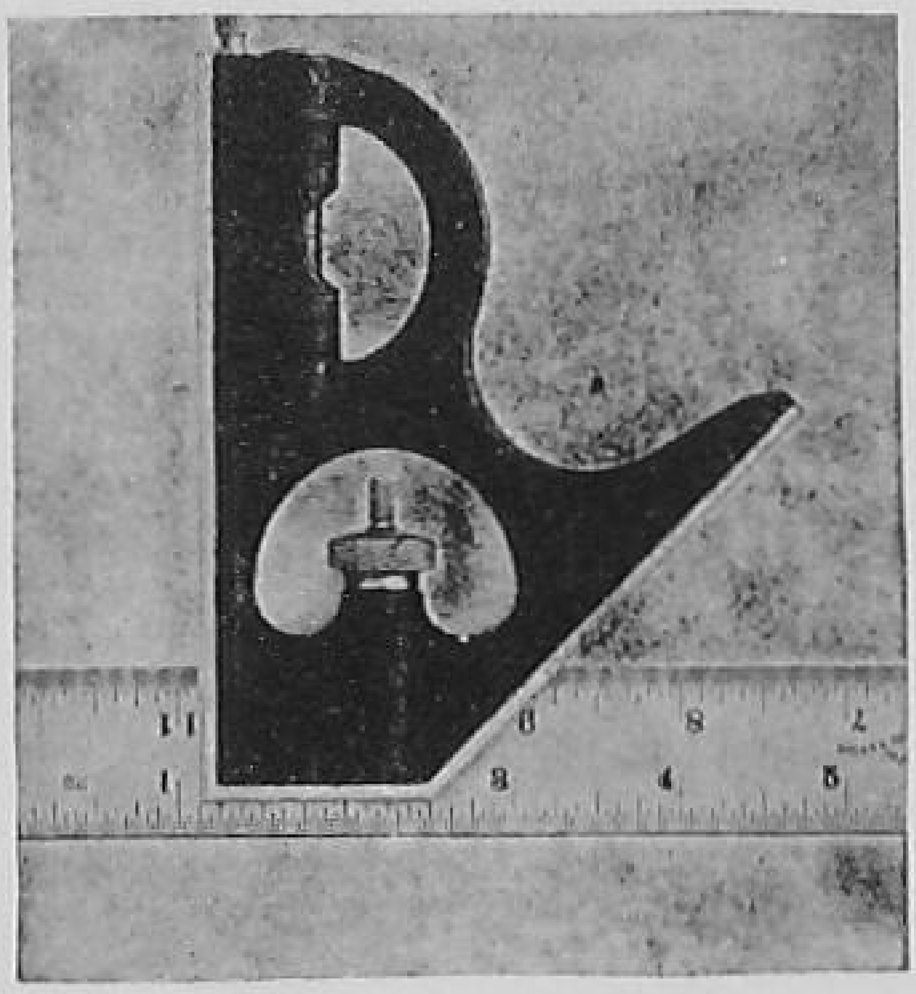


Fig. 72. Combination, or universal square.

angles to the edge of the blade and the other side at an angle of 45 degrees to the blade.

3. Using a crosscut saw held in the position shown (Fig. 73), saw off the 15″ piece of wood. The cut is made on the side of the line away from the 15″. The saw is held so that the tooth edge forms approximately a 45-degree angle with the surface of the board. There are two general types of hand saw: the crosscut saw and the ripsaw. The crosscut saw is used for sawing across the grain of wood, and the ripsaw is used for sawing with the grain.

The size of the teeth of a saw is usually given as the number of points to an inch. The number of points per inch is always one more than the number of teeth per inch. It is evident that 4 points per inch means larger teeth than 10 points per inch. The number of points is usually stamped on the heel of the saw (see Fig. 74).

Some hand saws have a straight back, others a skewback. The straight back is a little heavier and a little stiffer. To prevent a saw from binding in the slot which it cuts, called the kerf, the teeth are set by bending the

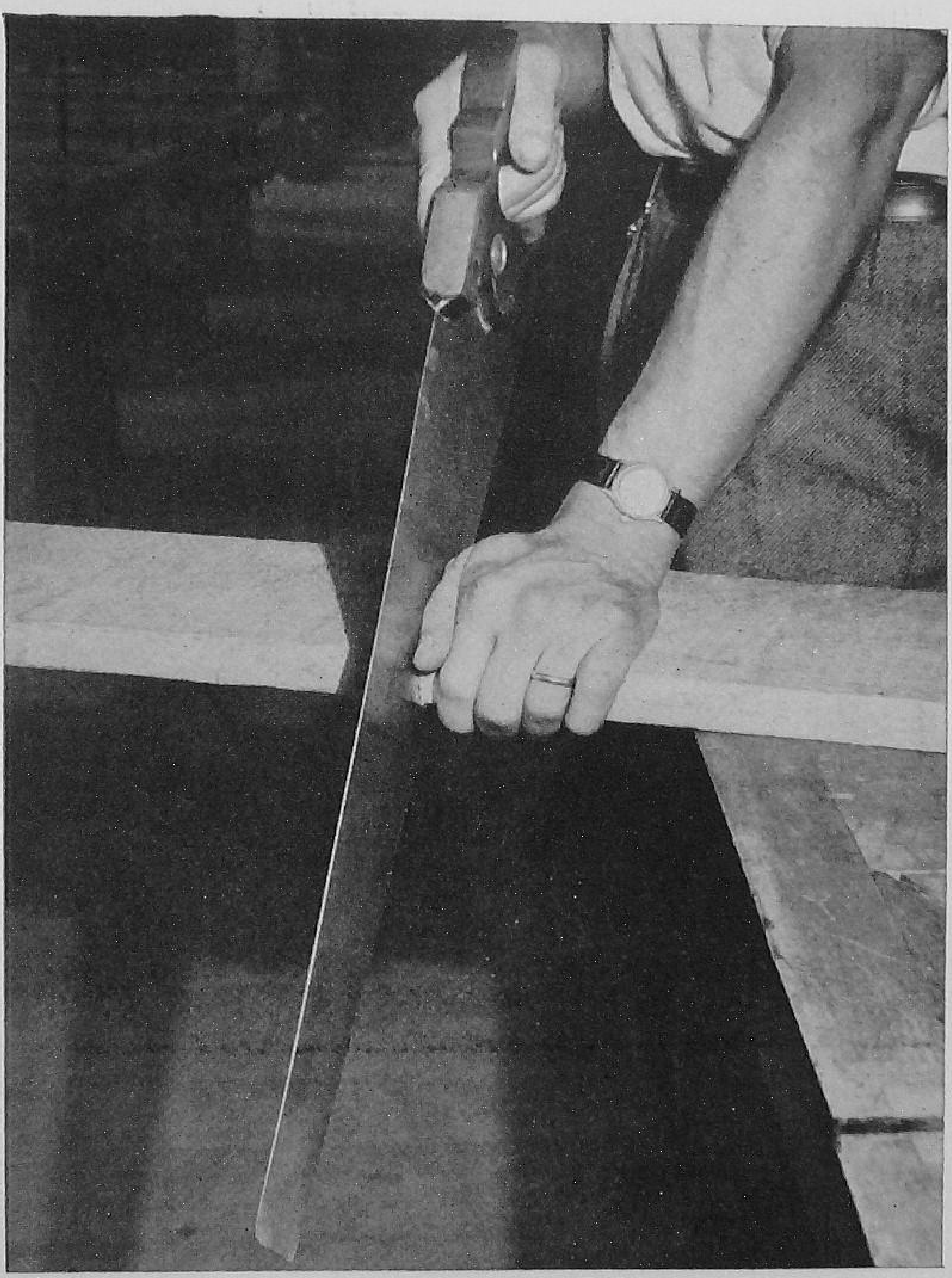


Fig. 73. Using a cross-cut saw.

points alternately to one side and then to the other. Only enough set is given the teeth to provide adequate clearance for the blade.

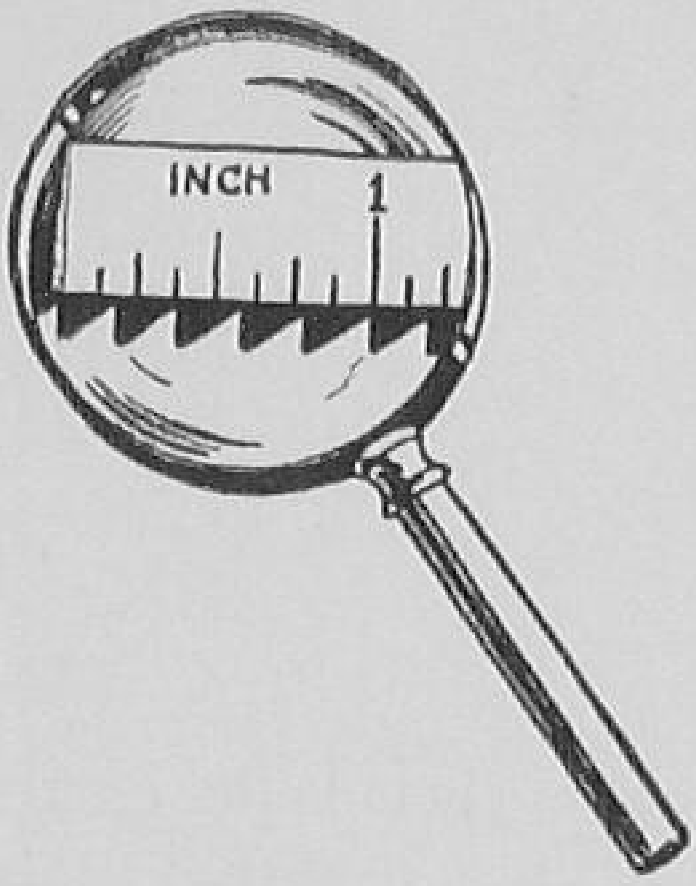


FIG. 74. Saw Teeth, points per inch.

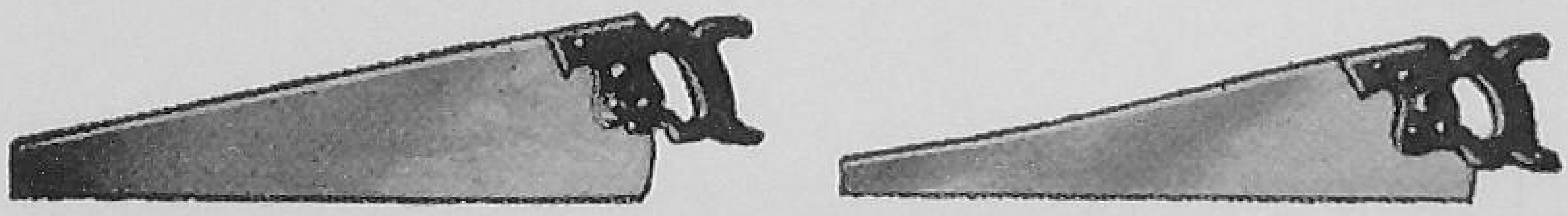


FIG. 75. Skewback and straight back saws.

The crosscut saw has teeth like small triangular knives which cut the fibers of the wood as the saw moves across them. It is made in lengths from 20″ to 26″. For all-around use an 8- or 10-point crosscut saw is best (see Fig. 76).

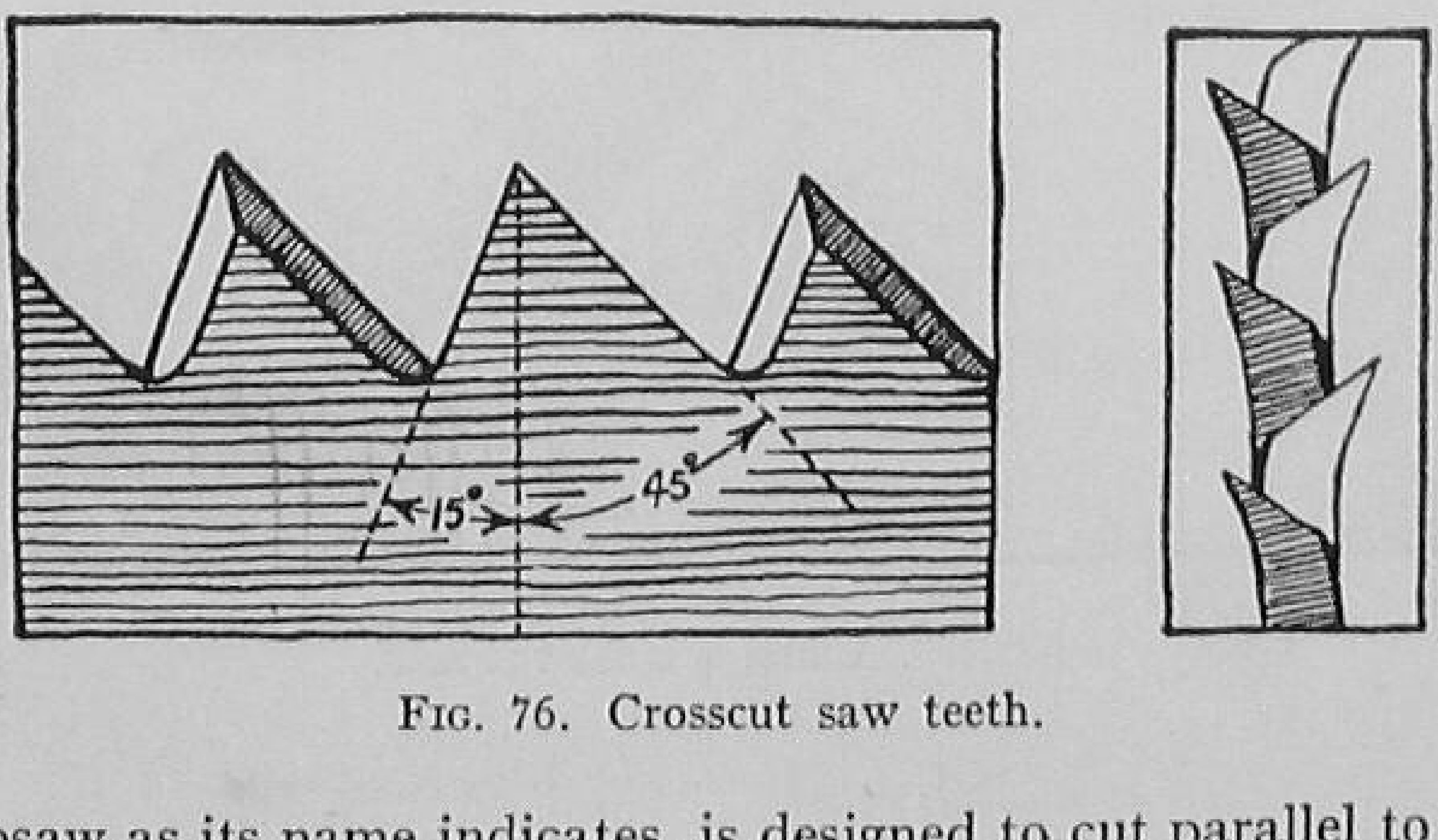


FIG. 76. Crosscut saw teeth.

The ripsaw as its name indicates, is designed to cut parallel to the grain of the wood. Except for the shape of the teeth, the ripsaw is similar to the

crosscut saw. The teeth of the ripsaw are chisel edges, as shown in the diagram, and are filed straight across. It will be noticed that the front of each tooth is nearly perpendicular to the blade of the saw. The teeth of a

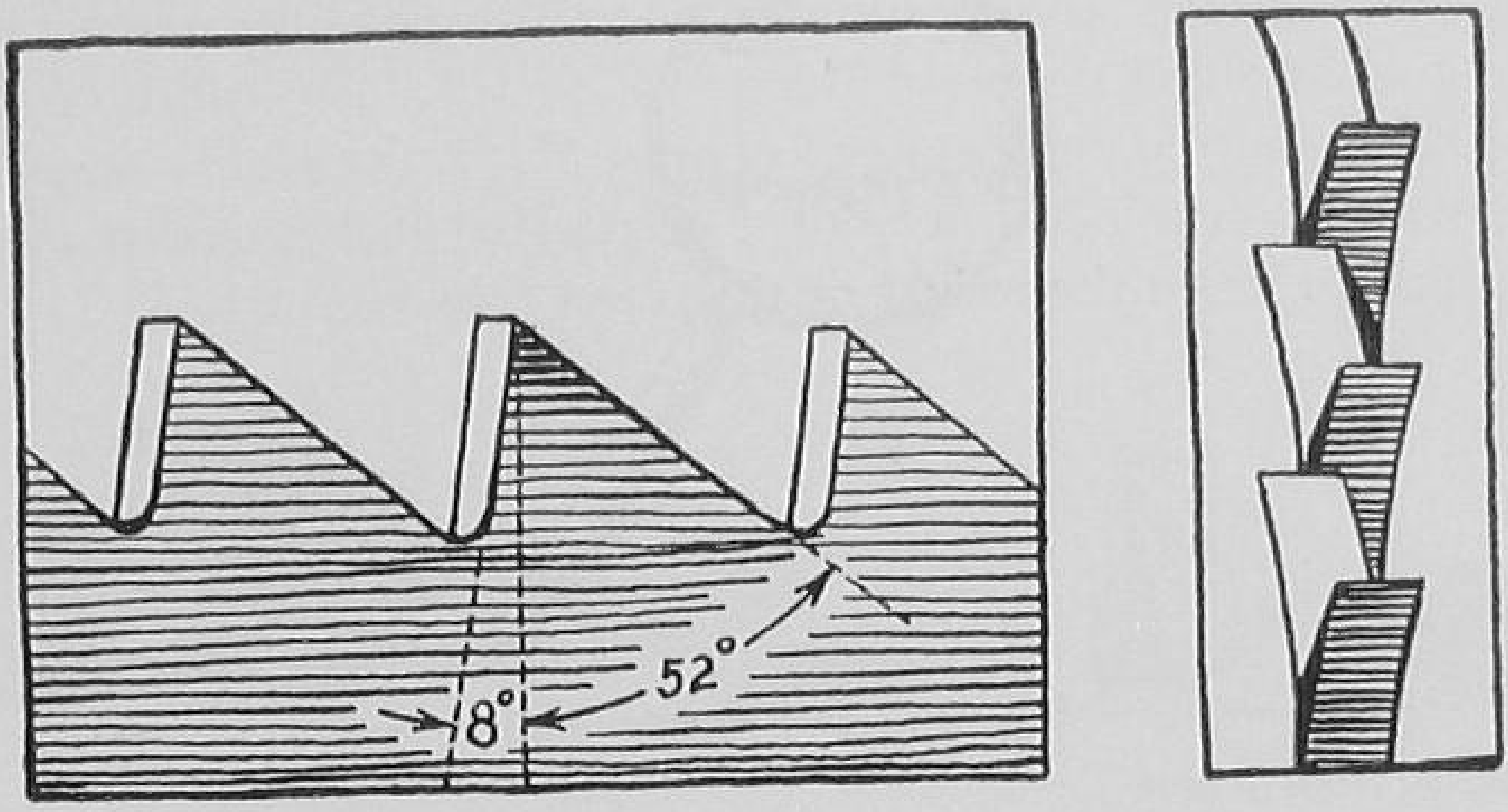


FIG. 77. Rip saw teeth.

ripsaw cut like vertical chisels, each tooth cutting out a small portion of the wood. The teeth on a ripsaw are not set quite as much as the teeth on the crosscut saw (see Fig. 77).

The ripsaw usually ranges in length from 20 inches to 26 inches. For general purposes a 5- to 7-point ripsaw is preferable.

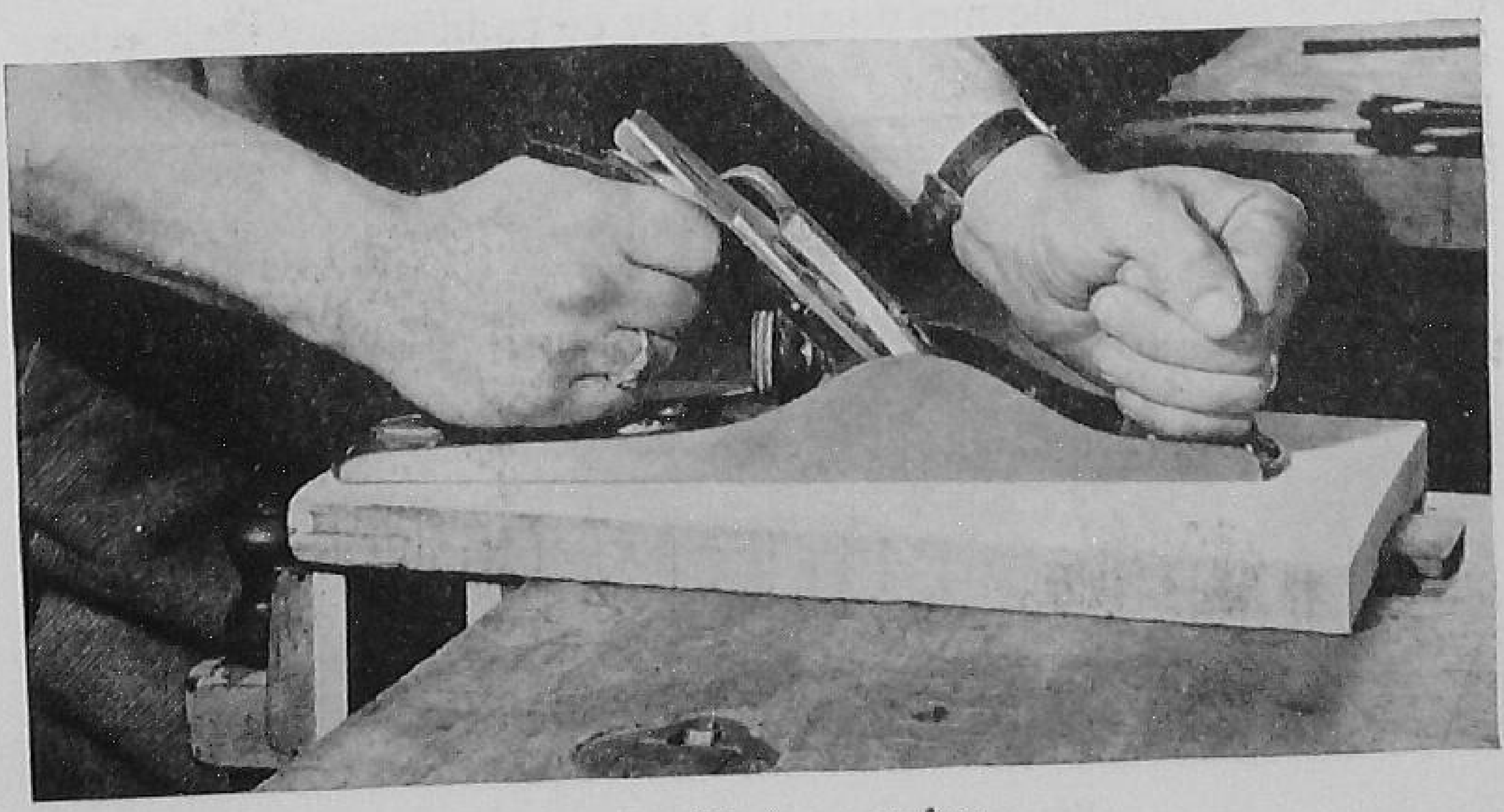


FIG. 78. Planing a surface.

4. Clamp the 15-inch piece of wood in a bench vise and plane one surface smooth and flat. The plane shown in Fig. 78 is a jack plane and the position of the hands is the same for either a jack plane or a smooth plane.

The smooth plane is used to plane broad surfaces and to finish work before sandpapering. It may also be used to plane edges and ends. The length of a smooth plane varies from 5½″ to 10″. The width of the cutting blade, called the plane iron, is usually 2″. These planes may be purchased with a smooth bed or with a corrugated bed intended to reduce friction and to lessen the weight of the plane (see Fig. 79).

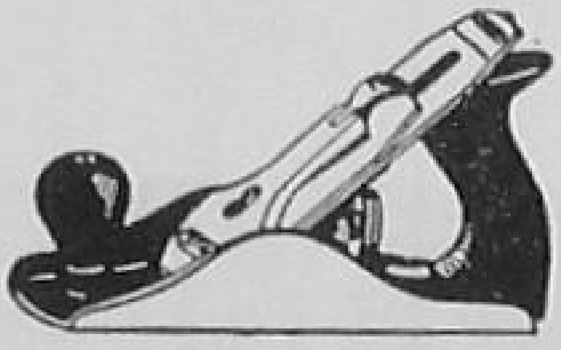


FIG. 79. Smooth plane.

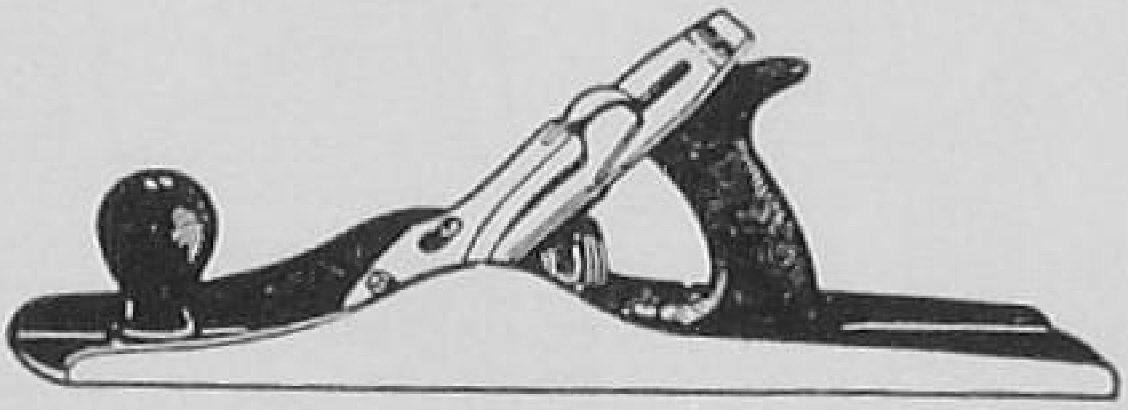


FIG. 80. Jack Plane.

The jack plane is approximately 14″ or 15″ long and 2″ or 2¼″ wide and is used for all-around work. The plane iron is ground almost straight and the corners are slightly rounded (see Fig. 80).

The plane is adjusted for cutting a light or heavy shaving by turning the adjusting nut shown in front of the handle. Planing is done by starting on one edge of the surface and taking a stroke the entire length of the piece, then overlapping each stroke, plane entirely across the surface. If the wood tears and the surface becomes rough, it may be an indication that you are

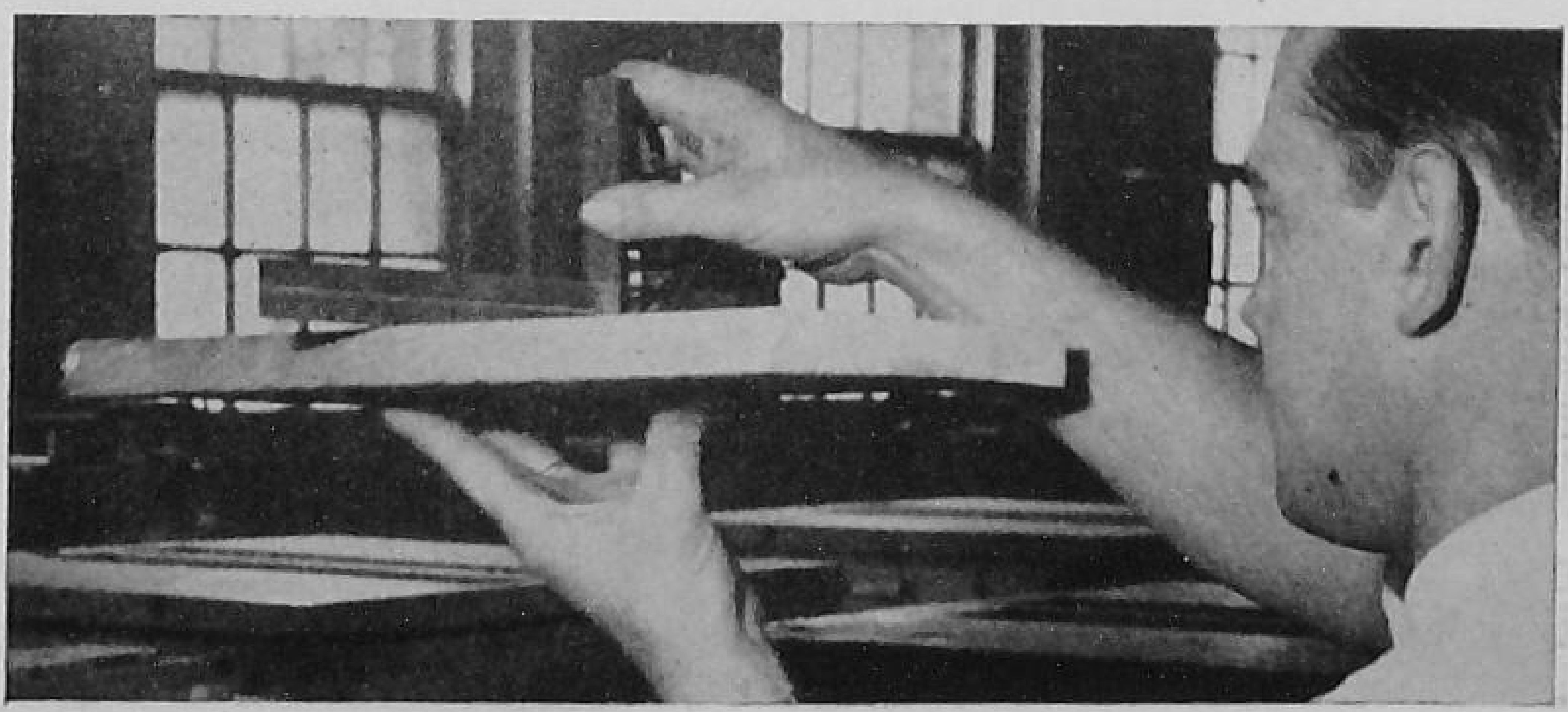


FIG. 81. Testing surface for flatness.

planing against the grain of the wood. To overcome this, reverse the direction of planing.

When the surface appears to be smooth and level, the try square is held on the surface of the board as shown in Fig. 81 and the blade is slid lightly along the surface. If no light shows under the blade it is an indication that the surface is flat. If light shows under the blade of the try square, the high spots must be planed down. Next test the surface of the board for trueness by holding the blade of the try square diagonally across the board (Fig. 82). This test will indicate if the board is twisted. When the surface is absolutely true and flat a light pencil mark is placed on the finished surface. This surface is now known as the *working face.*

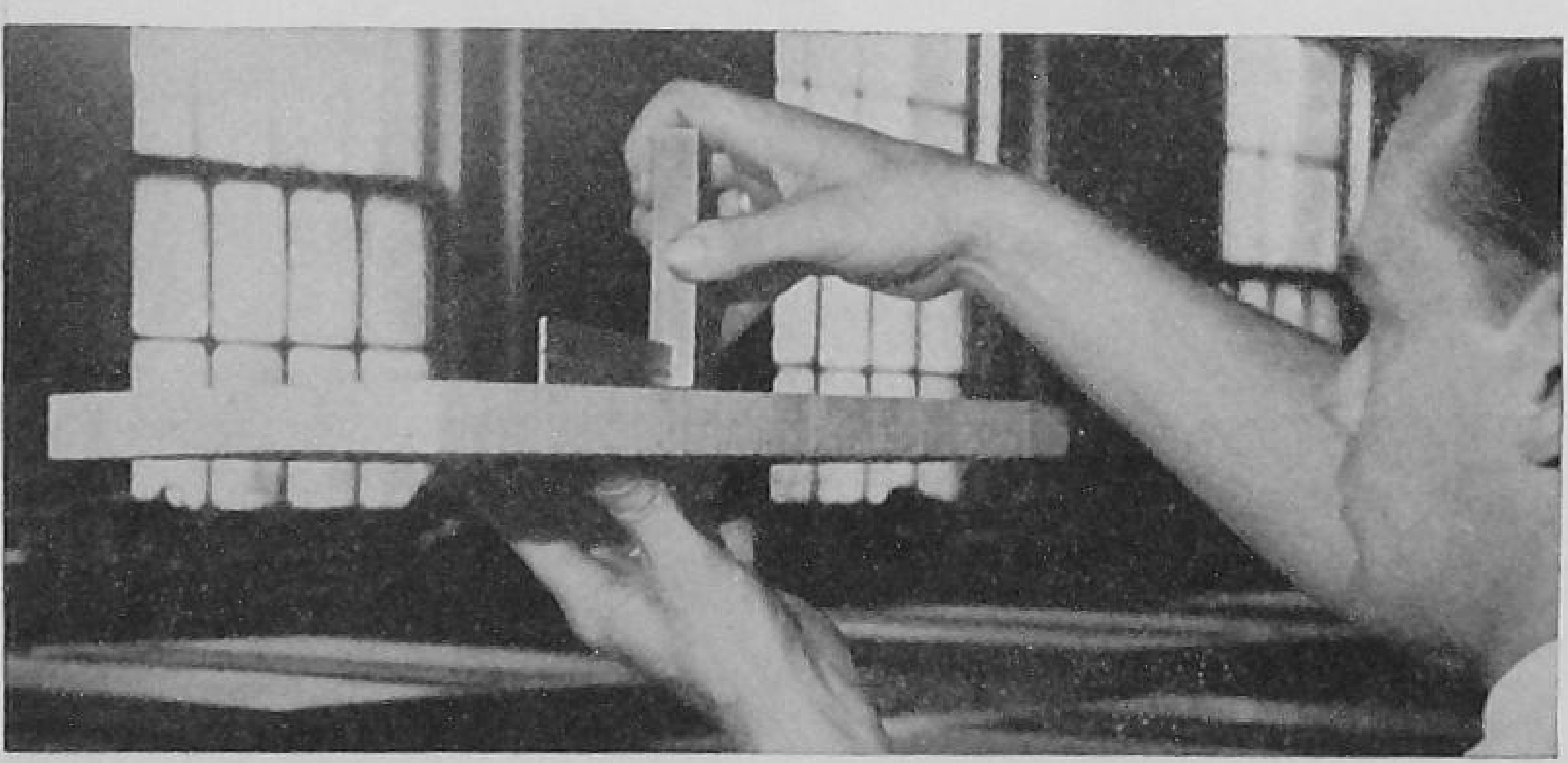


FIG. 82. Testing a surface for trueness.

5. Clamp the wood in the vise and, holding the plane as shown in Fig. 83, take several strokes along the edge of the board until the edge appears smooth. Planing must be done in the direction of the grain. This edge must now be tested to see if it is square with the working face. The handle of the try square is held tightly against the working face and the blade touches the edge of the board (Fig. 84). Slide the square lightly along the edge, sighting for light under the blade. If any light shows, the high spots must be planed until no light appears. The edge must also be checked lengthwise as shown in Fig. 85 to make sure that the edge is flat. When this edge is square with the face, and flat, two pencil marks are made on the finished edge which is known as the *working edge.*

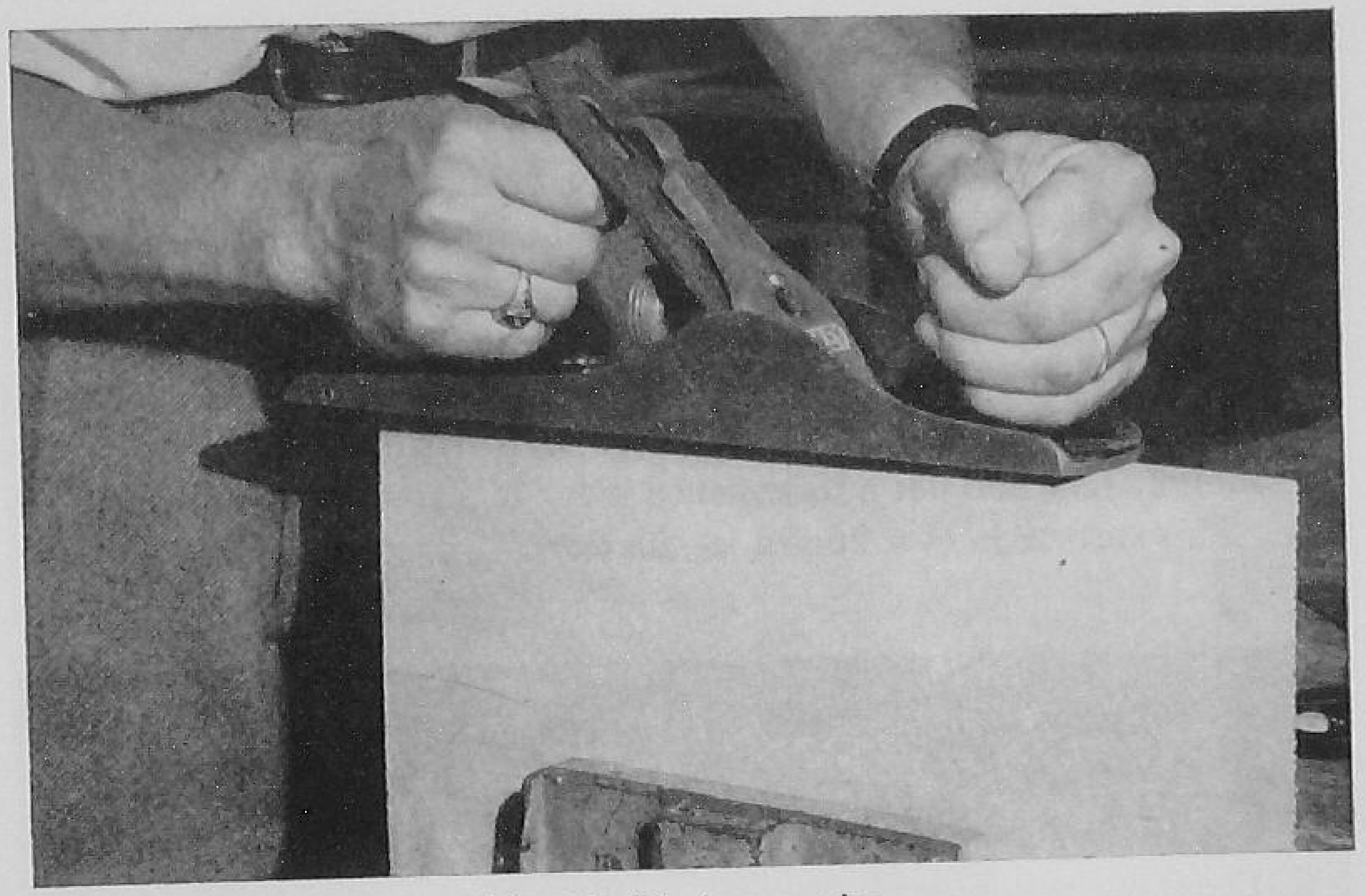


FIG. 83. Planing an edge.

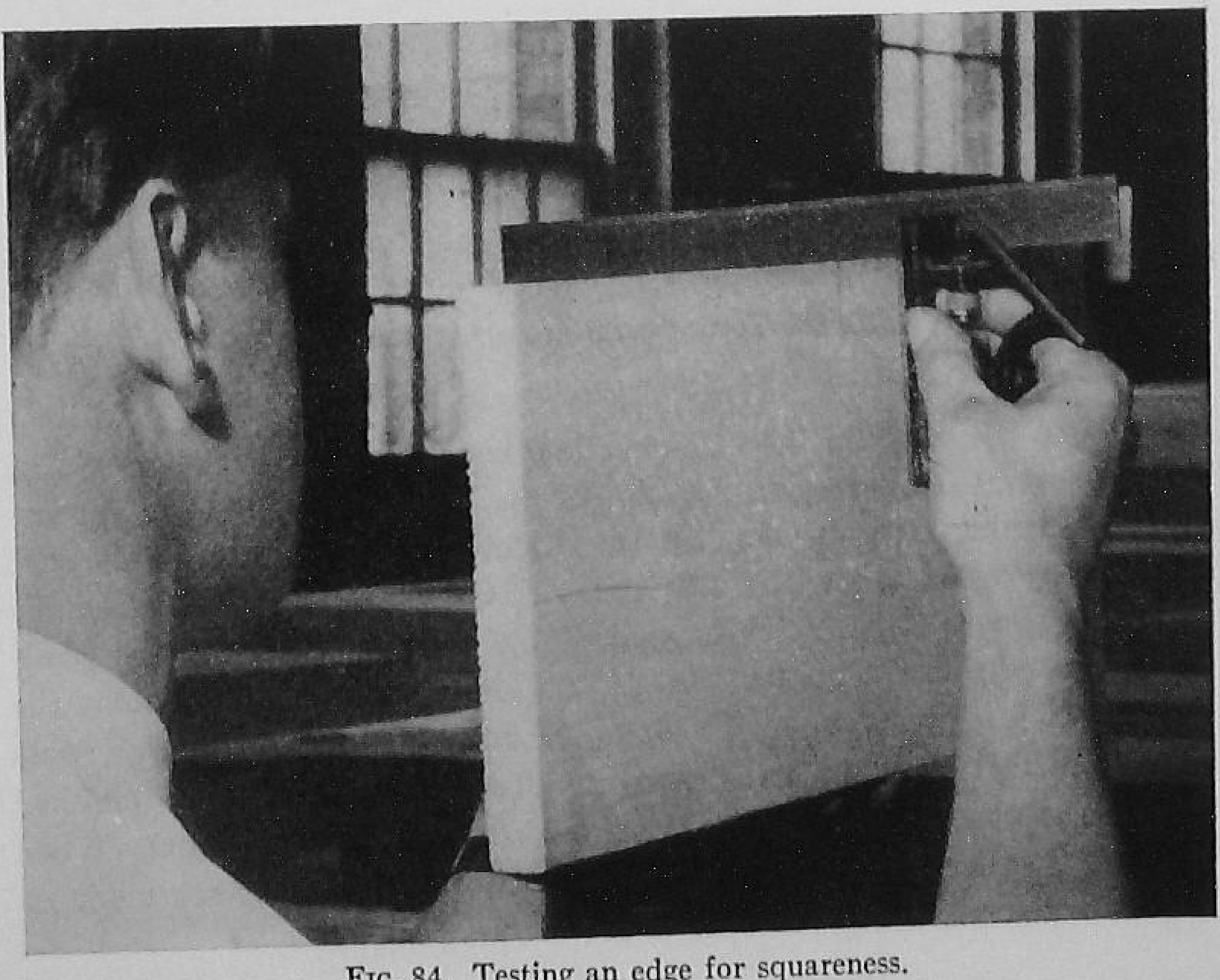


FIG. 84. Testing an edge for squareness.

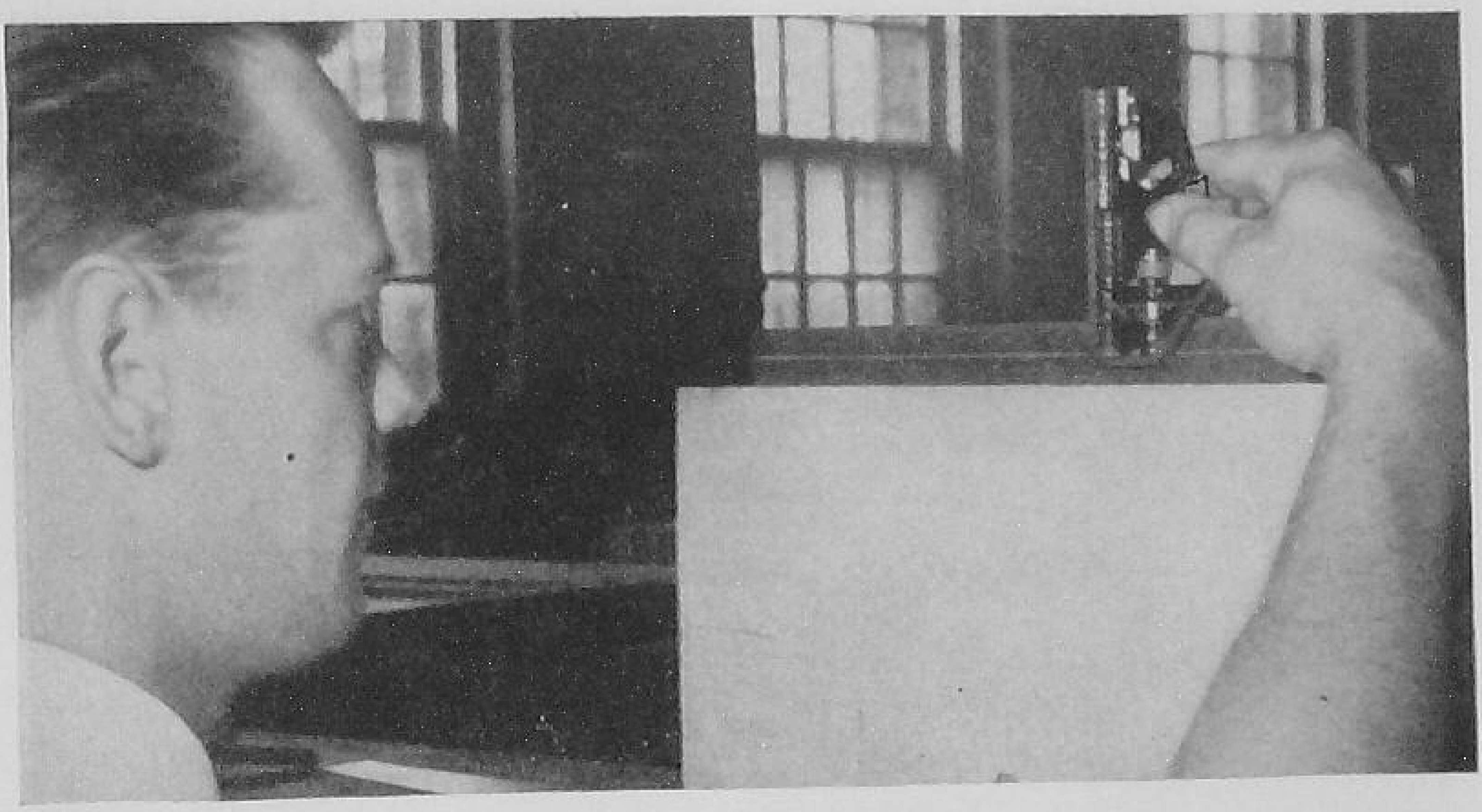


FIG. 85. Testing an edge for flatness.

6. Plane one end square with the working face and with the working edge. If the end is planed all the way across the piece, there is a good chance that the corner will chip. There are three common methods used to prevent this chipping. (*a*) On the rough edge, opposite the *working edge*, plane a small bevel as shown in Fig. 86*A*. When planing toward this

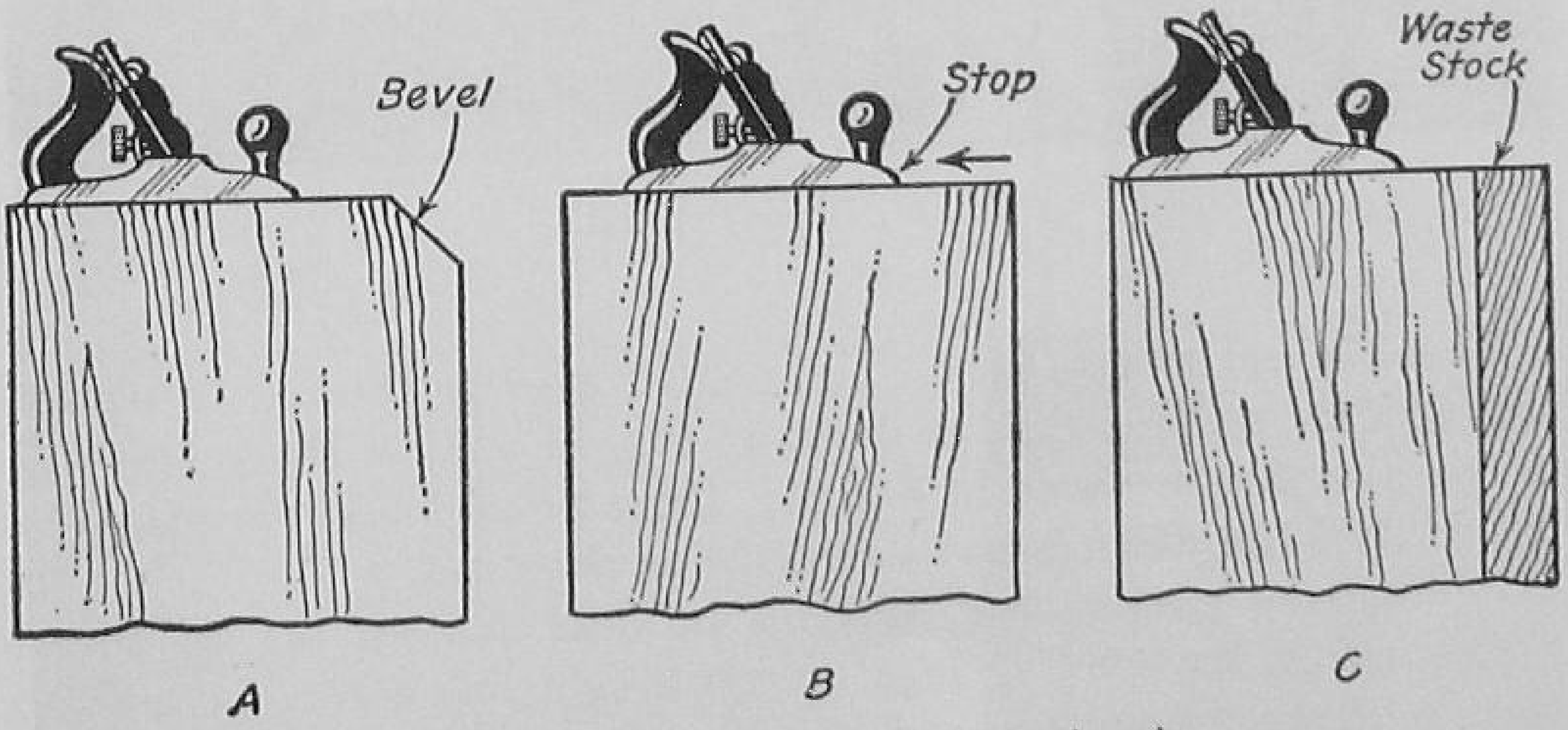


FIG. 86. Three methods of planing end grain.

corner, chipping will not occur. (*b*) Plane halfway across the end of the board, then plane halfway in the opposite direction (Fig. 86*B*). (*c*) Clamp a piece of waste wood tightly against the rough edge of the board and plane

toward this waste piece (Fig. 86*C*). If it is clamped tightly, there should be no chipping. Method (*a*) is used in Fig. 87. The plane should be adjusted to take a very fine cut for end planing.

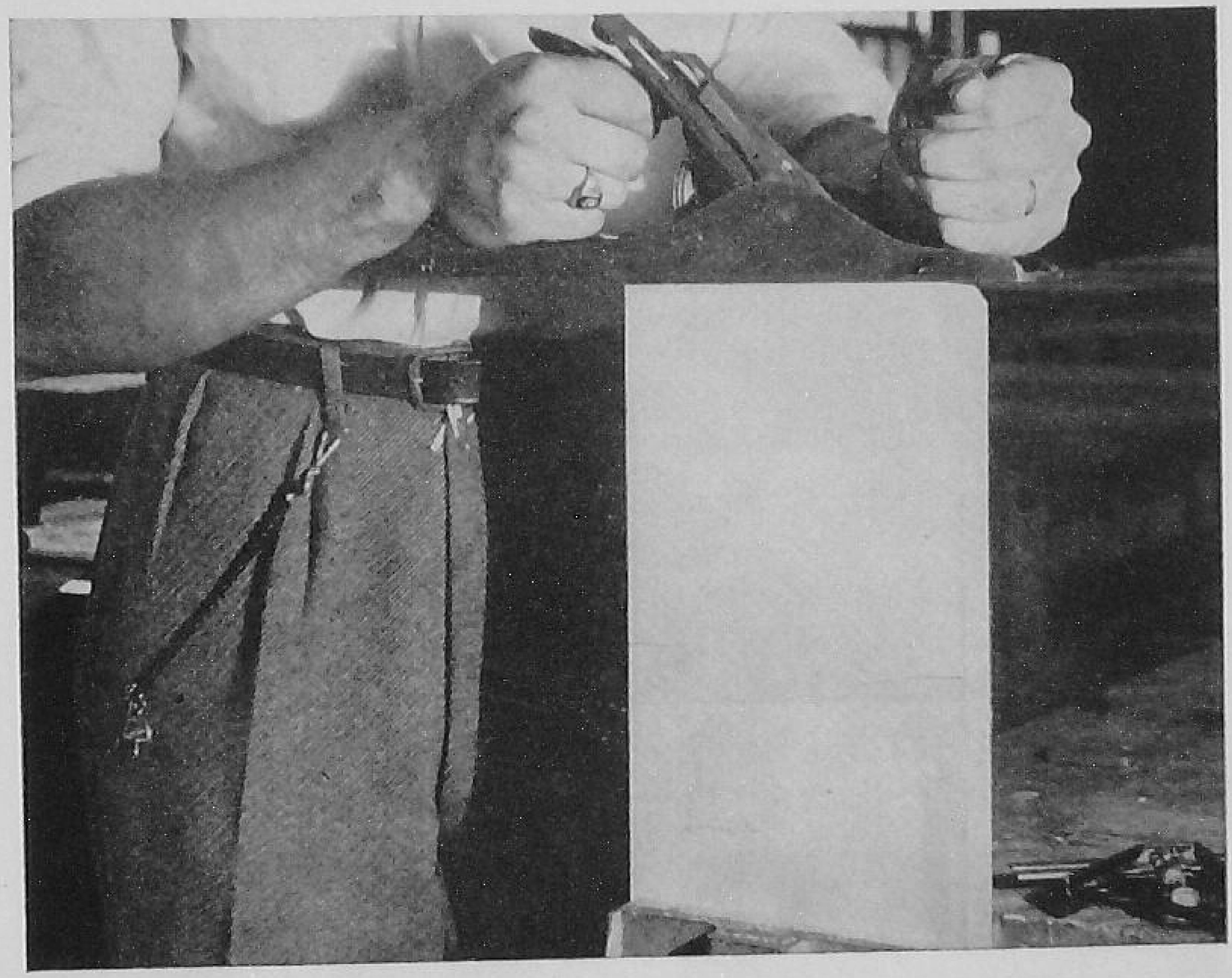


Fig. 87. Planing an end.

When the end appears smooth and even, it must be checked for squareness with the working edge as shown in Fig. 88 and for squareness with the working face as shown in Fig. 89. Three pencil marks are placed on this finished end which is now called the *working end*.

7. From the *working end*, measure 14″ and, holding the try square handle against the *working edge*, square a light line across the *working face*. With the crosscut saw, saw off the excess wood by cutting just along the line on the waste side (Fig. 90). Leave just the pencil line showing. Using the same procedure as used in planing the working end, square this second end just removing the pencil line. The board should now be exactly 14″ long.

8. Hold the rule as shown in Fig. 91 and from the *working edge* mark off 6½″ in several places on the working face. Connect these marks with a straight pencil line running the length of the board. Using a ripsaw as shown in Fig. 92, cut off the excess wood from the rough edge of the board.

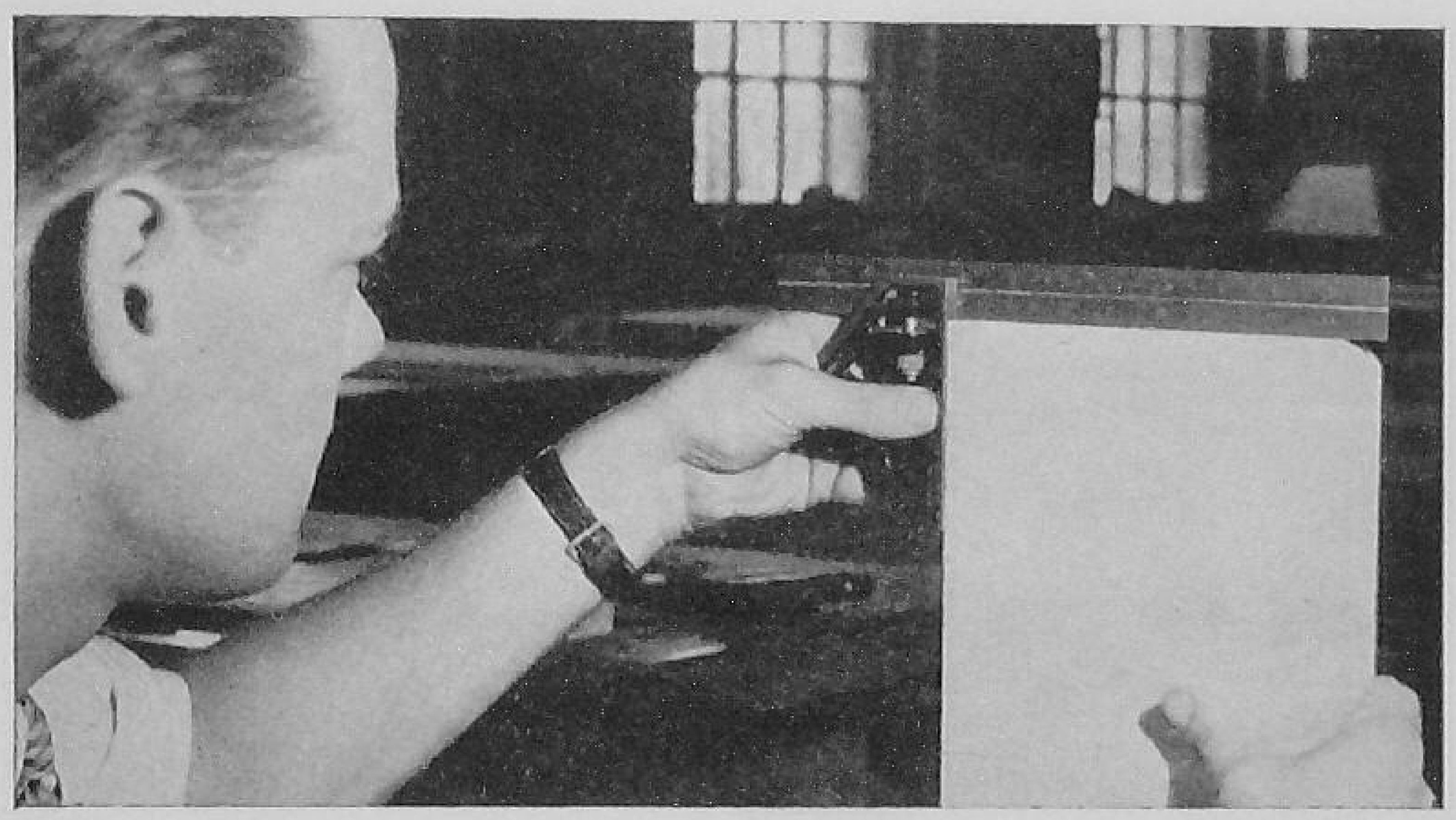


FIG. 88. Testing an end for squareness with the working edge.

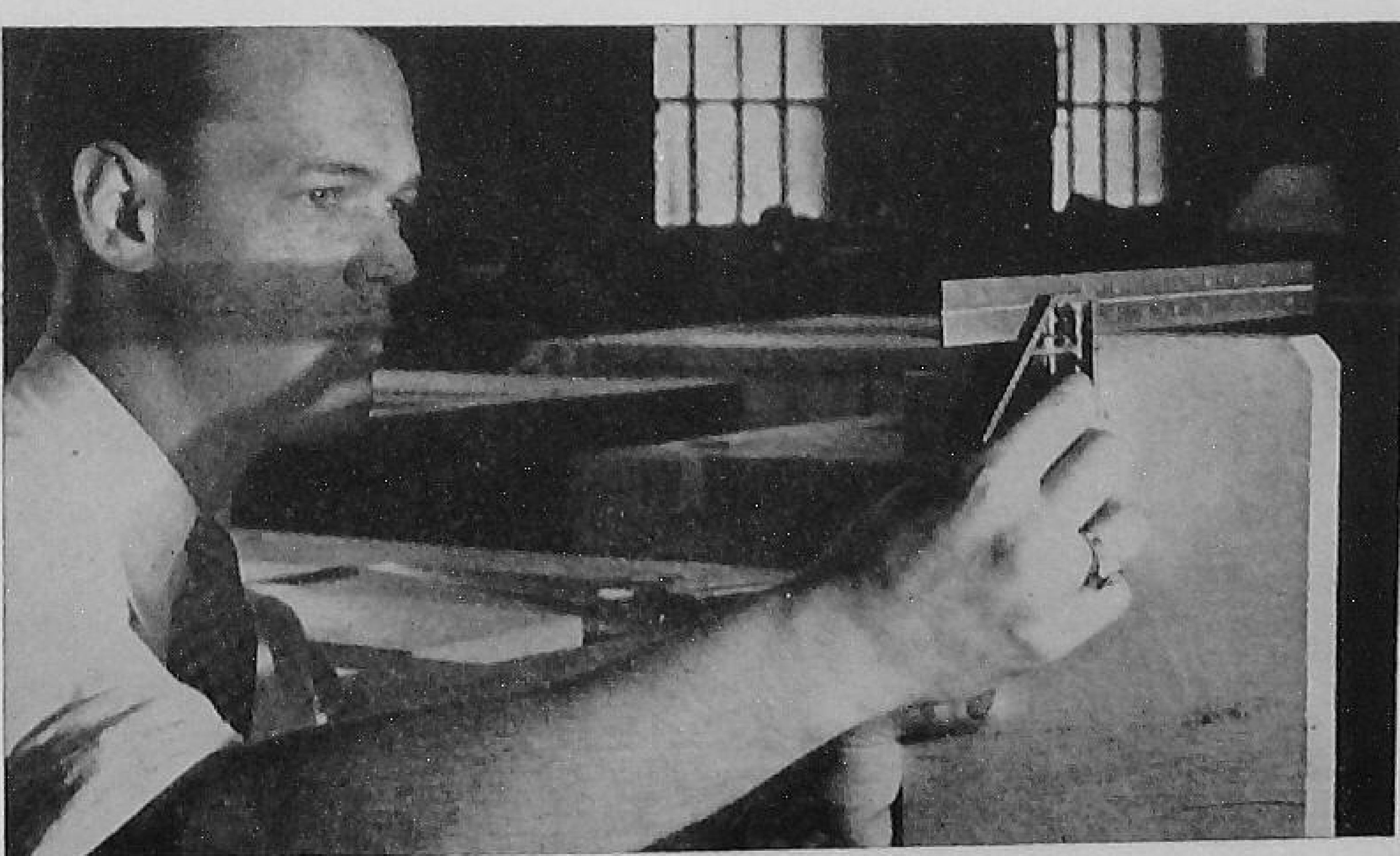


FIG. 89. Testing an end for squareness with the working face.

Saw just outside of the line and hold the ripsaw so that the tooth edge of the saw and the face of the board form a 60-degree angle. Plane this edge down to remove the line and check for squareness as was done with the *working edge*. The board should now be exactly 6½″ wide.

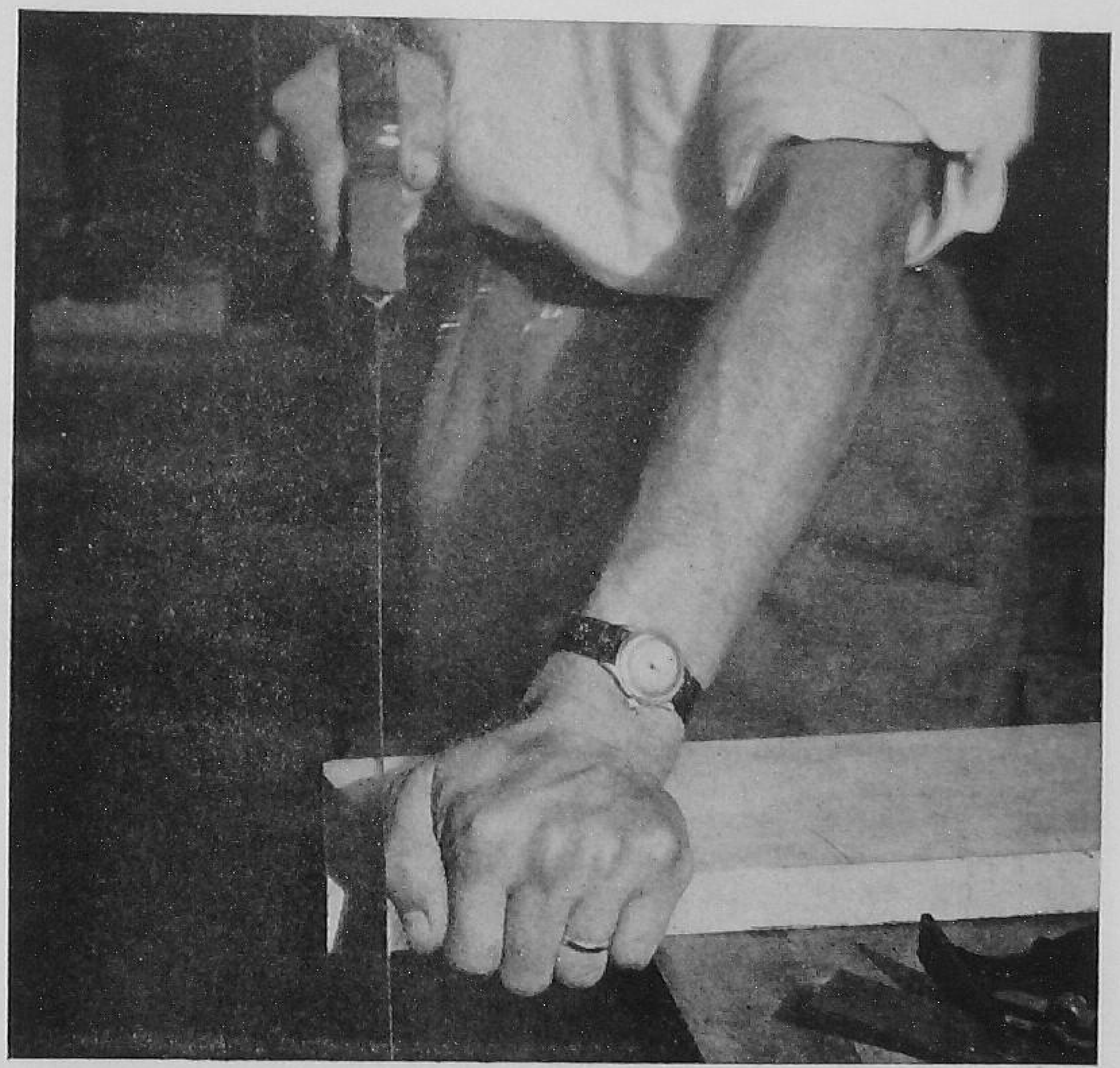


Fig. 90. Sawing to length.

9. The marking gage (Fig. 93) is set at ½ inch, measured from the point of the spur to the face of the head. Holding the marking gage as shown in Fig. 94 with the face of the head held tightly against the *working face* and the spur on the edge, make a light mark all the way around the board on both edges and both ends. This line should then be parallel with the face. The last surface is now planed down to this line as was done in

FIG. 91. Measuring to width.

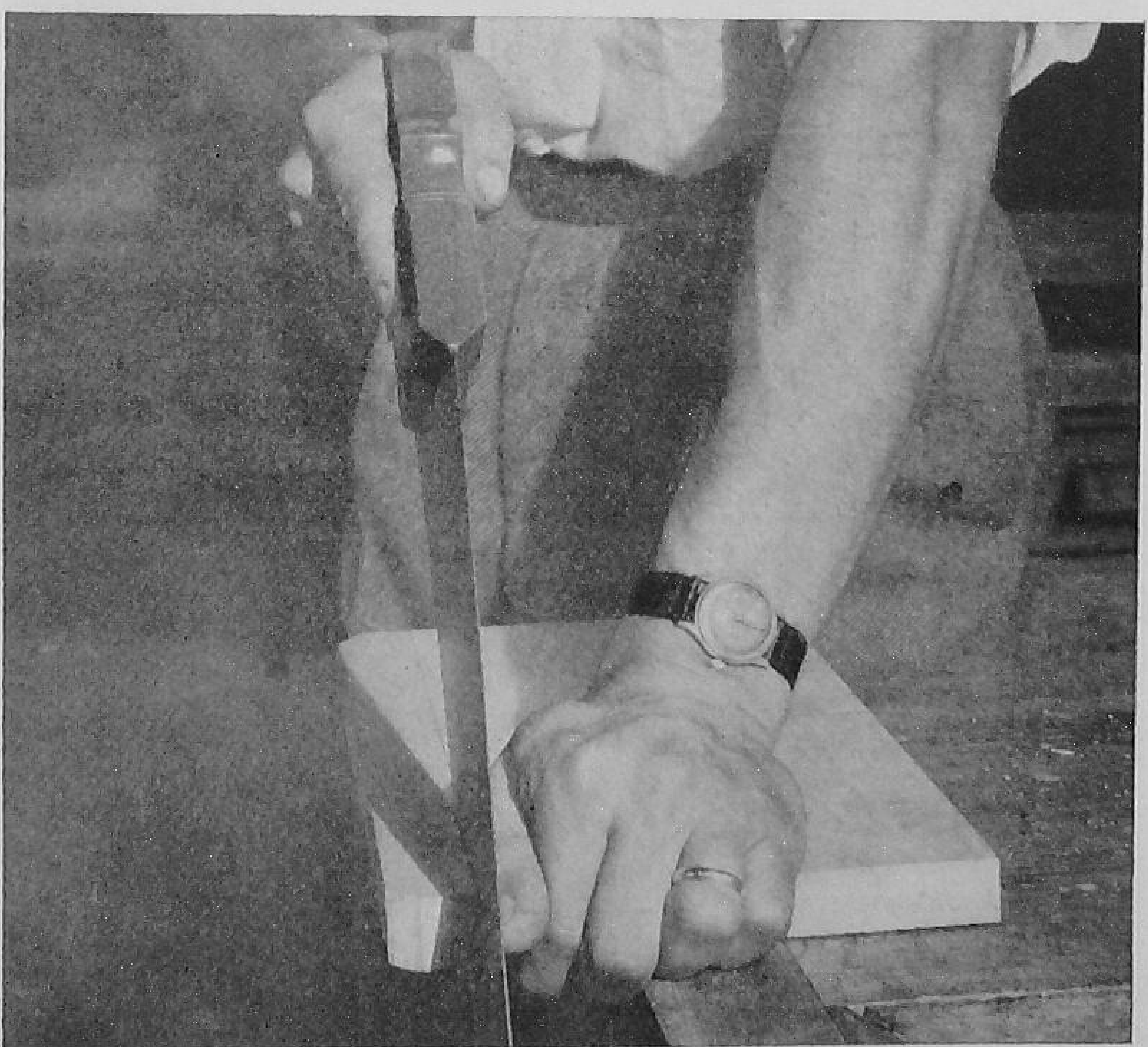


FIG. 92. Using rip-saw, cutting board to width.

planing the working face. Check for smoothness and evenness. The board should now be squared to exact dimensions of ½″ x 6½″ x 14″.

10. Lay out the chamfer around the edges as shown in the drawing and plane the chamfer.

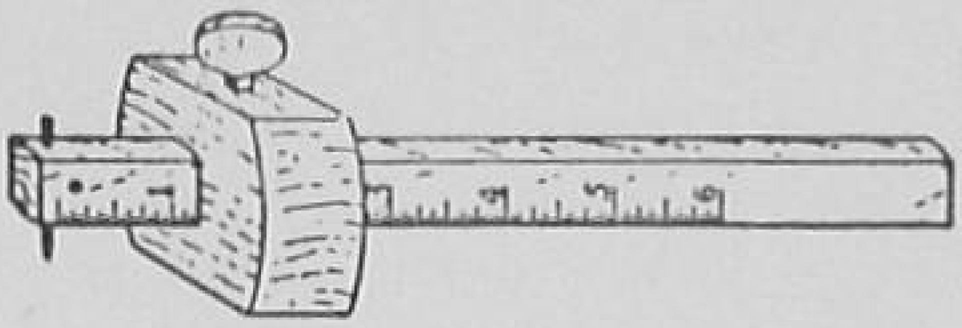


FIG. 93. Single marking gauge.

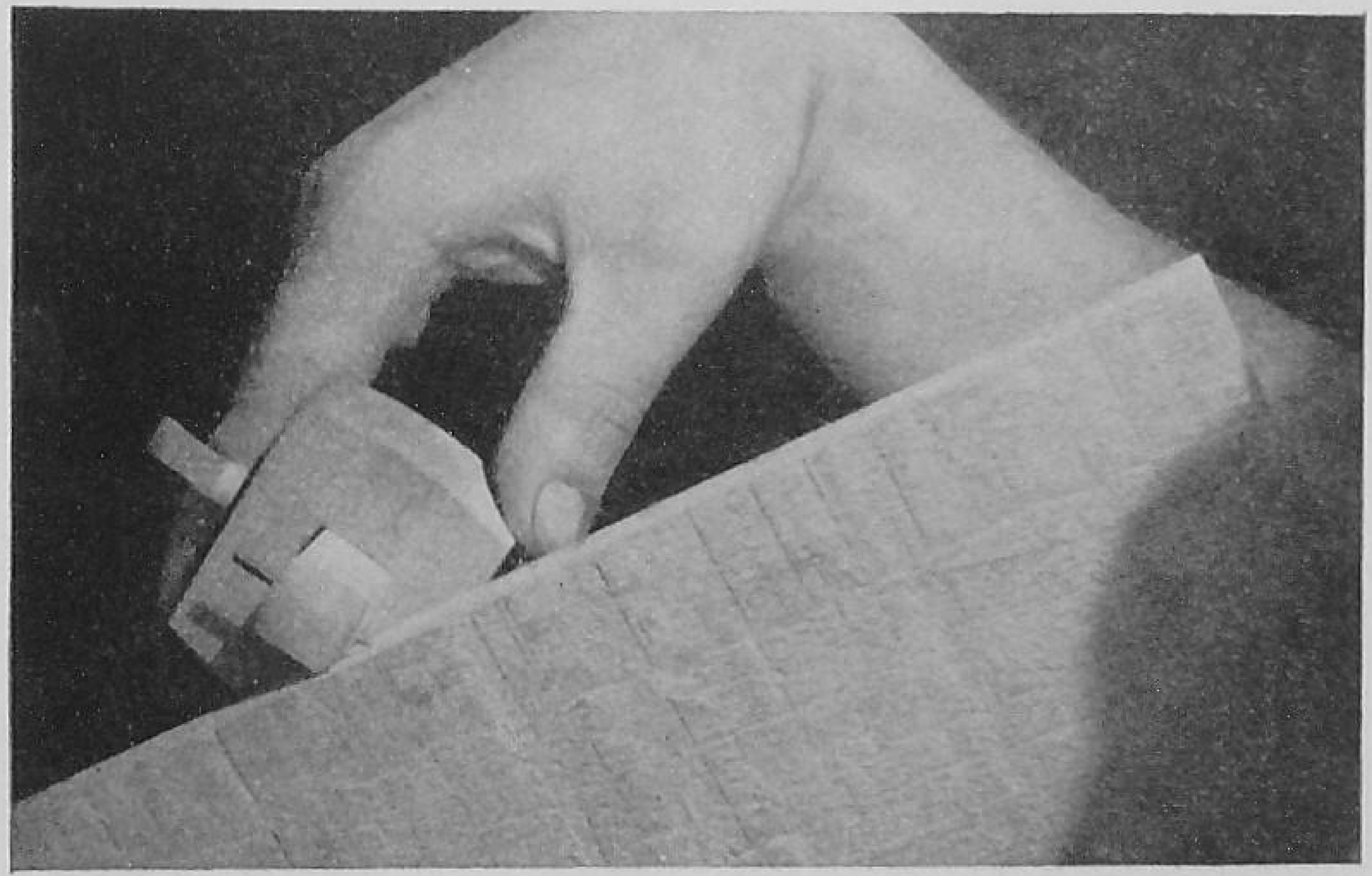


FIG. 94. Using a marking gauge.

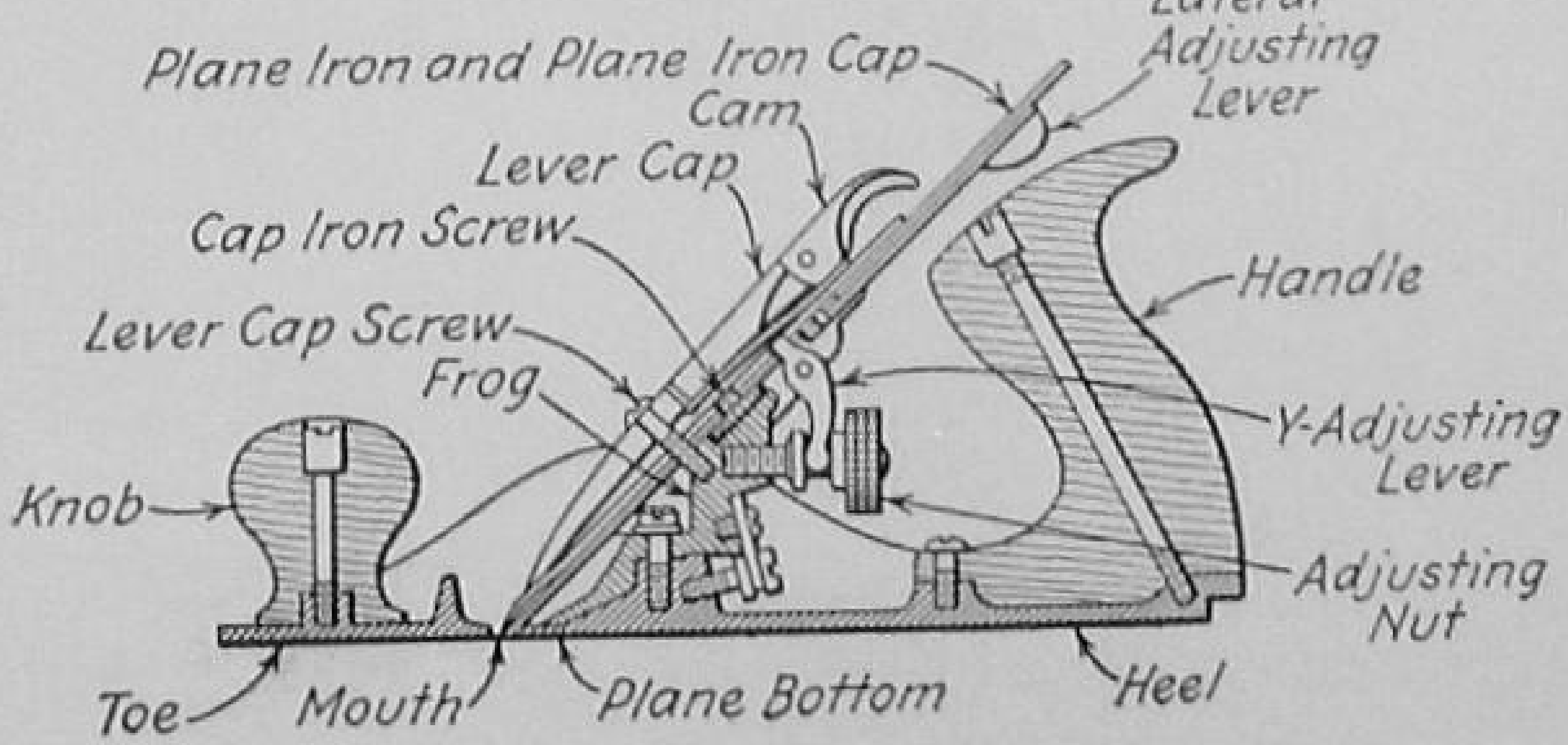


FIG. 95. Cut-away section of a plane.

Sharpening the Plane Iron. The woodcraft worker should be able to keep the cutting edge of the plane sharp. Less effort is required if cutting tools are always kept sharp. A cut-away section of a smooth plane is shown (Fig. 95) in order to familiarize the user with the names of the parts of the plane. The jack plane parts are the same.

Function of the Principal Parts.

1. The frog assembly provides a definite angle at which the plane iron is mounted. It contains the Y adjusting lever, lateral adjusting lever, and the adjusting nut. It also can be used to increase or decrease the opening

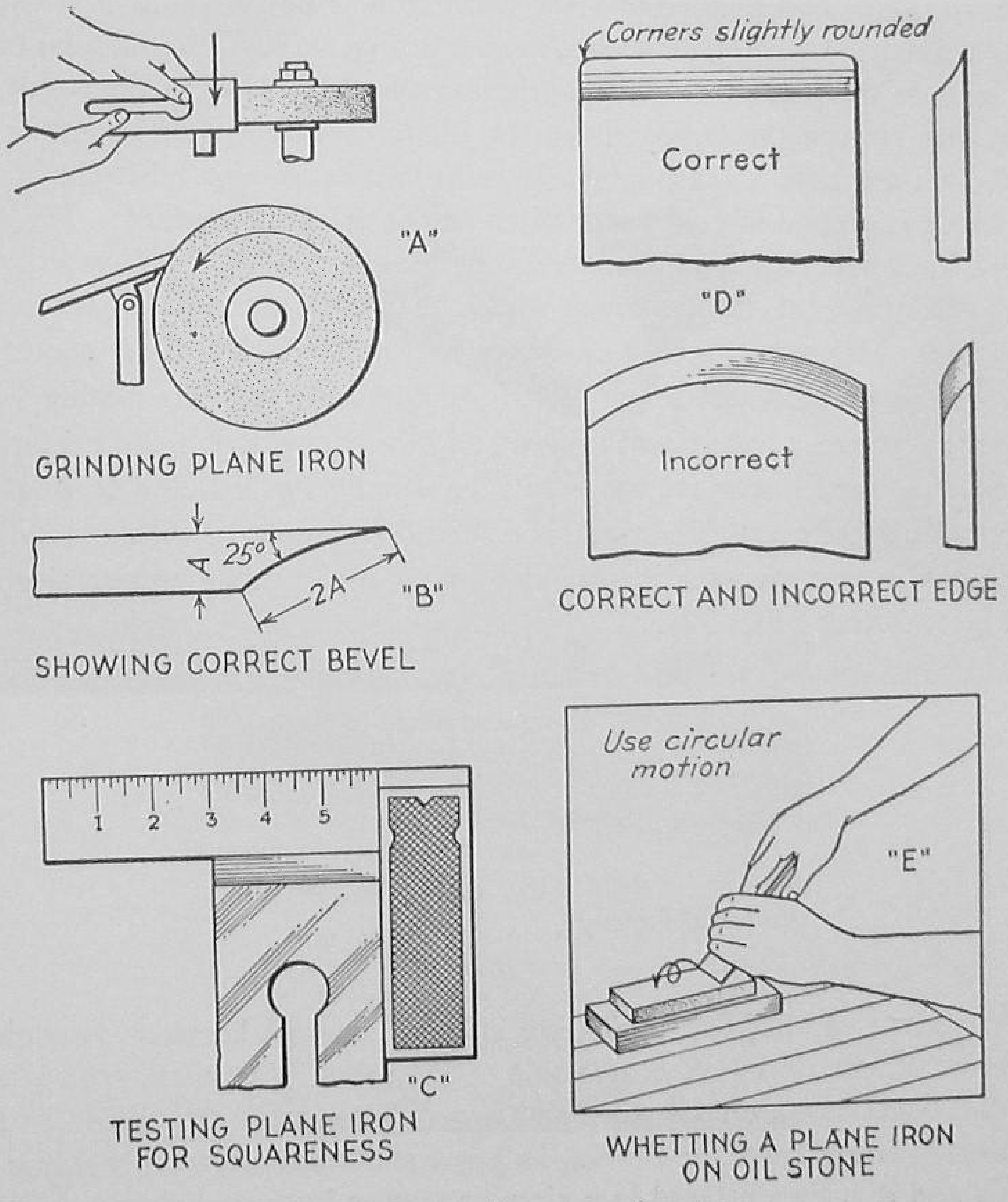


FIG. 96. How to sharpen a plane iron.

of the throat. This particular adjustment is used where exceptionally smooth surfaces are desired, expecially on cross-grained woods. Frog adjustment screws are provided, enabling one to change the position of the frog, depending on the type of wood being used and the shaving desired.

2. The Y adjusting lever, through the adjusting nut, regulates the depth of cut, that is, the thickness of the shaving.

3. The lateral adjusting lever is provided to enable one to adjust the cutting edge of the plane iron parallel to the mouth.

If the cutting edge is very dull or nicked, it will be necessary to grind the cutting edge on a grinding wheel. Remove the blade, or plane iron, from the plane and then remove the plane iron cap. The plane iron is then held against the grinding wheel as shown in Fig. 96*A*. Care must be taken not to hold the plane iron on the grinding wheel too long as the edges will burn and remove the temper from the blade. Without proper temper the blade will not hold a sharp edge. Burning can be eliminated if the end of the blade is dipped in cold water often as the grinding proceeds. Fig. 96*B* shows the correct angle of the bevel; the bevel is slightly "hollow ground" from the shape of the grinding wheel. The cutting edge is tested for squareness with a try square as shown in Fig. 96*C*. Fig. 96*D* shows the correct and an incorrect shape of cutting edge. After a sharpening wheel is used to remove excess metal rapidly, and to remove any nicks, a sharpening stone is used to remove the wire edge usually formed, and to whet the edge to final keenness. The workshop should be equipped with at least one combination sharpening stone about 8″ x 2″ x 1″, coarse on one side and fine on the other (Fig. 97).

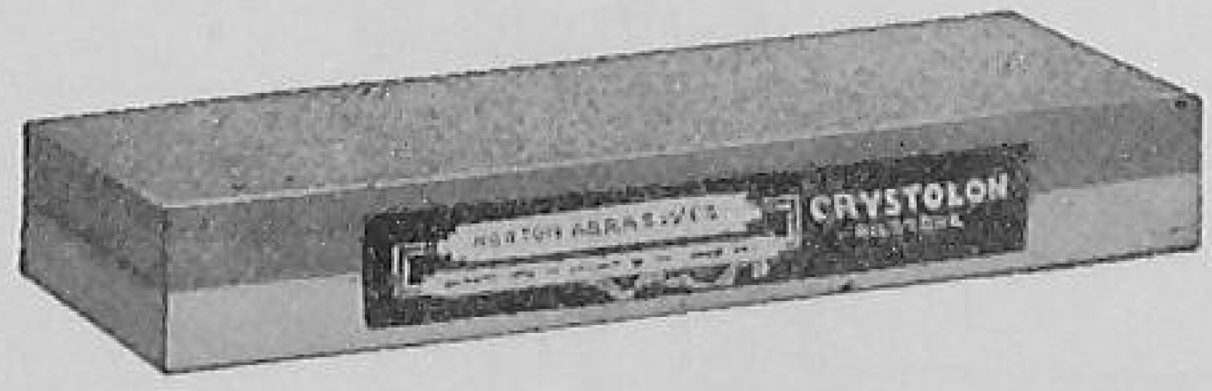


Fig. 97. Combination stone. (*Courtesy of Norton Company*).

A mixture of one-half lubricating oil and one-half kerosene is squirted from an oil can on to the coarse side of the stone. The plane iron is then placed, bevel down, on the stone and raised slowly until the oil can be seen squeezing from under the bevel. This is the correct angle for holding the blade and it is then rotated in a circular motion back and forth across the

surface of the stone (Fig. 96E). This process will cause a wire edge (rough edge) to appear on the back of the blade. Turn the blade over and lay it perfectly flat on the surface of the stone and again rotate in a circular motion. This operation is repeated until the wire edge is removed, then turn the stone over and repeat the entire process on the fine side of the stone until a keen cutting edge has been obtained. If the cutting edge was not nicked or very badly dulled, the whetting operation may be performed without grinding thus keeping a keen cutting edge at all times.

11. The wood should now be obtained for the handles. Cut out two pieces of walnut, mahogany, gumwood, or some other wood with a color contrasting to that of the base of the tray. Pieces should be 5/8" thick, 2 1/4" wide, and 5 1/2" long. Proceed to square these two pieces as was done for the base. It is good procedure to plane a working face on each piece, then a working edge on each piece, then a working end on each piece. Measure and cut both pieces to 5" long and square this other end. Measure and mark both pieces to 1 7/8" wide and square to this dimension. Mark both pieces to 1/2" thickness and plane to the finished size. This completes the squaring of the handles.

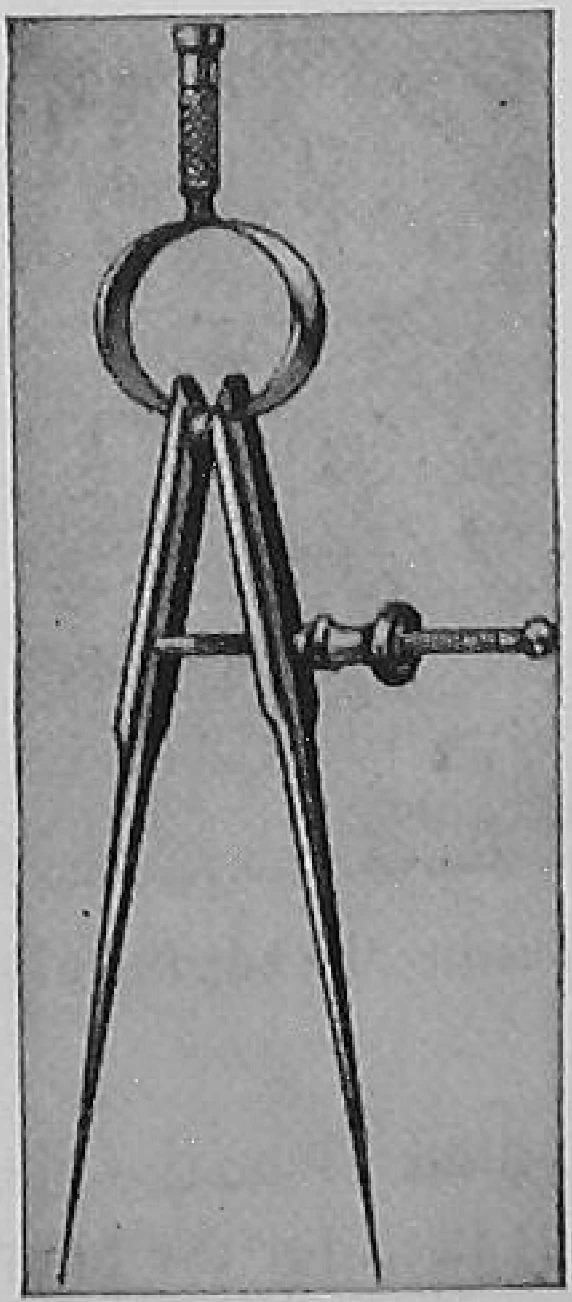


FIG. 98. Dividers.

12. On each handle, mark off the lines for cutting out the grips and the rounded corners as shown on the working drawing. Arcs and circles are marked on wood with dividers (Fig. 98) which are used the same as an

ordinary compass. Both legs of the dividers being sharply pointed permits a finer and more accurate marking than can be done with the pencil point of a compass when used on wood. On the center lines, bore ¾" holes through each handle. Insert the coping saw blade in one hole and saw out the wood between the holes as shown in Fig. 99. Cut the rounded corners with a coping saw and then smooth all sawed edges with a wood file.

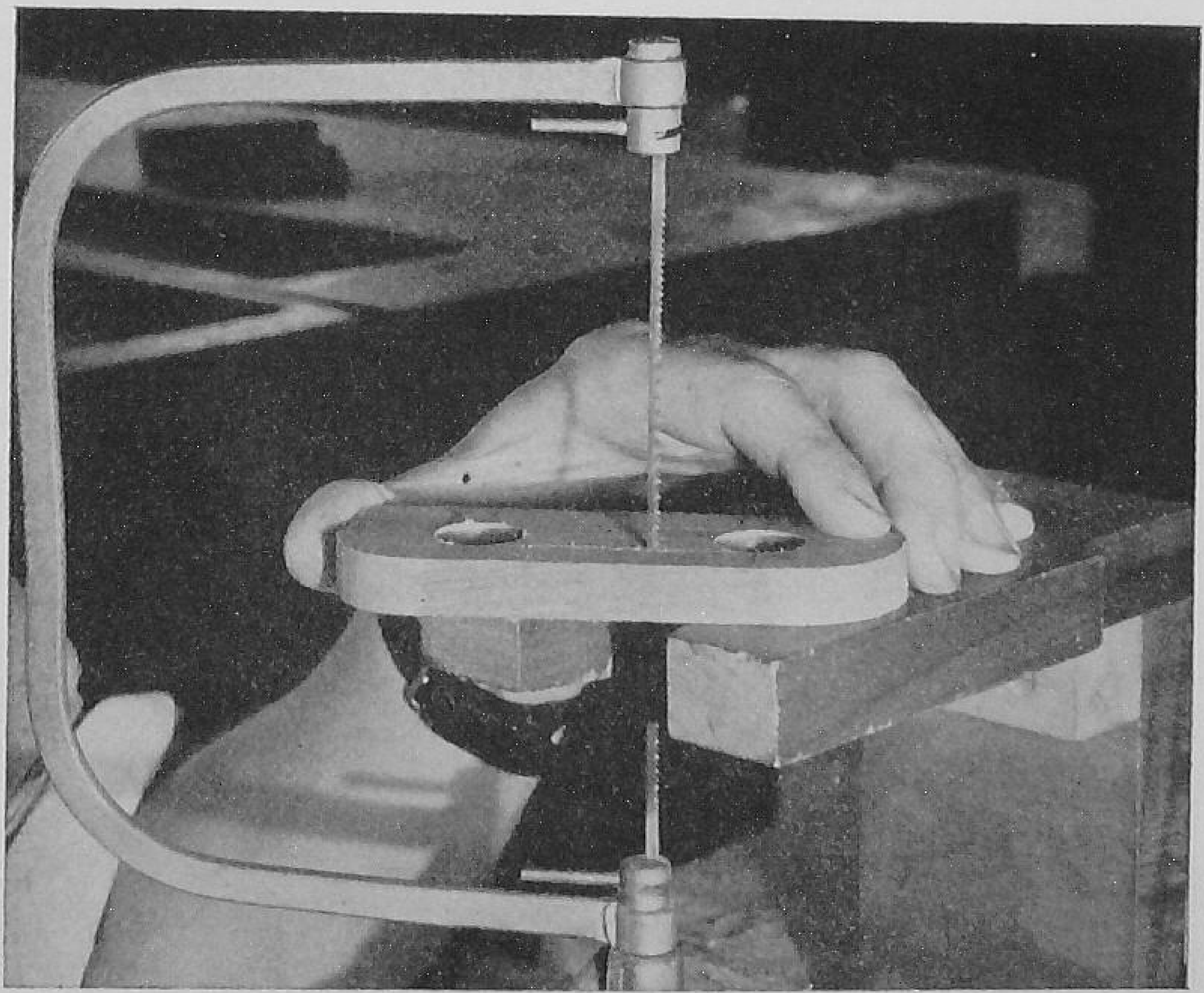


Fig. 99. Cutting the handles of the tray.

13. Cut out and square to dimensions the pieces for the side strips. Use the same kind of wood as that used for the handles.

14. Either an inlay picture (as shown in Chapter IV), a carving (as shown in Chapter V), or a burned design (as shown in next project) may be made on the base of the tray at this time.

15. Sand all parts thoroughly with 2/0 sandpaper.

16. Lay out and drill the holes for the screws for fastening the handles

according to the working drawing. Fasten the handles to the base using three, 3/4", No. 6 screws in each handle.

17. The side strips are now fastened in the position shown in the drawing. These may be glued with a liquid glue and clamped tightly with wood parallel clamps (Fig. 100). Leave the work in the clamps overnight. Side strips may be nailed with 3/4", No. 16 brads if clamps are not available.

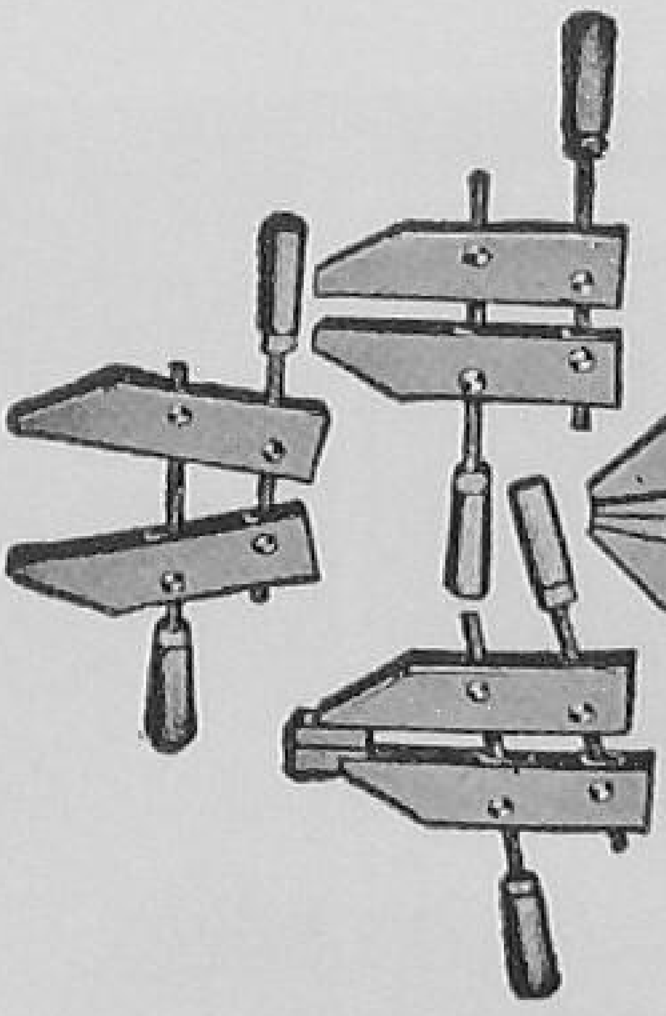


FIG. 100. Hand screws.

18. A final sanding using 4/0 sandpaper is now necessary. Be sure that all end-grain is sanded glass-smooth.

19. Apply a coat of white shellac and allow to dry overnight. Then rub with fine steel wool; apply a second and third coat of shellac, allowing each coat to dry thoroughly and rub with steel wool after each coat.

20. Pour a small amount of linseed oil on the surface of the tray, sprinkle some powdered pumice stone on the oil and, with a small pad made of soft cloth, rub the entire tray. Be careful not to cut under the shellac on the edges of the various parts of the tray. The pumice stone is a fine abrasive which will smooth out the shellac finish.

21. Wipe off all oil and pumice stone with a cloth moistened in benzine or naphtha and, when dry, apply a light coat of paste wax. After the wax stands for approximately 15 minutes, rub thoroughly with a soft clean cloth.

Tray No. 2

1. Square up piece for base to finished dimensions ½″ thick, 7½″ wide, and 15″ long.

2. Square up pieces for the two handles to finished dimensions ½″ thick, 1¾″ wide, and 6½″ long.

3. With a plane, round the edges of the handles as shown in the drawing.

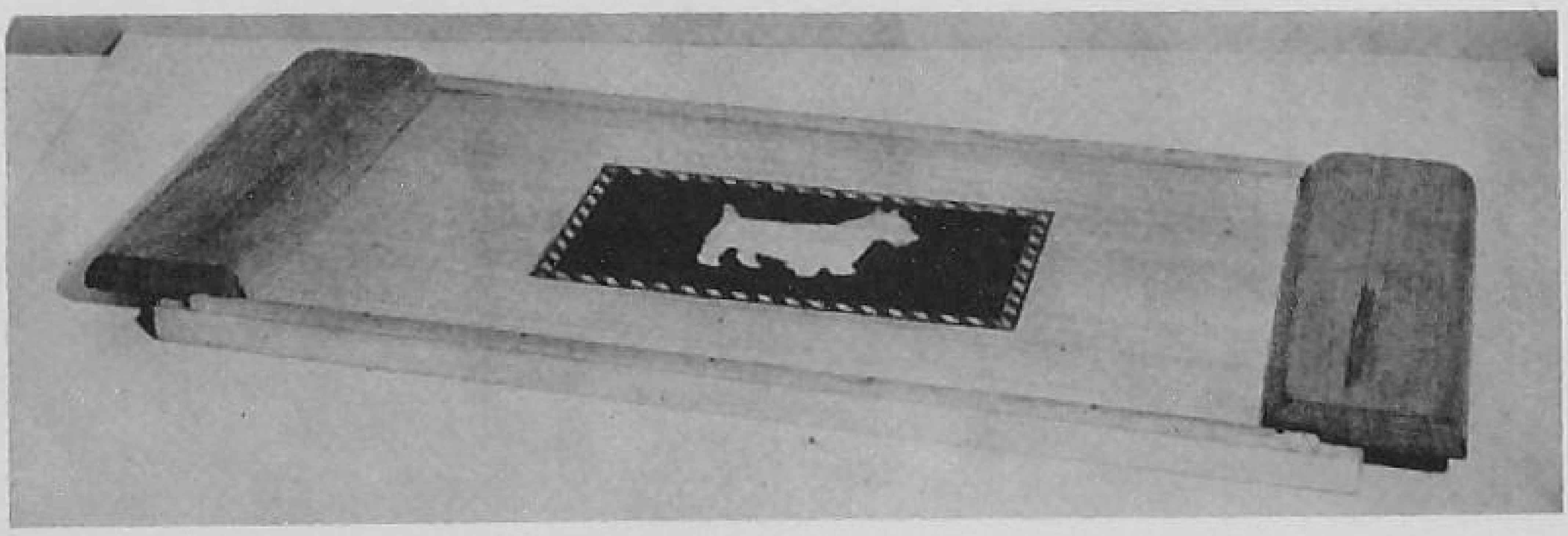


Fig. 101. Tray No. 2.

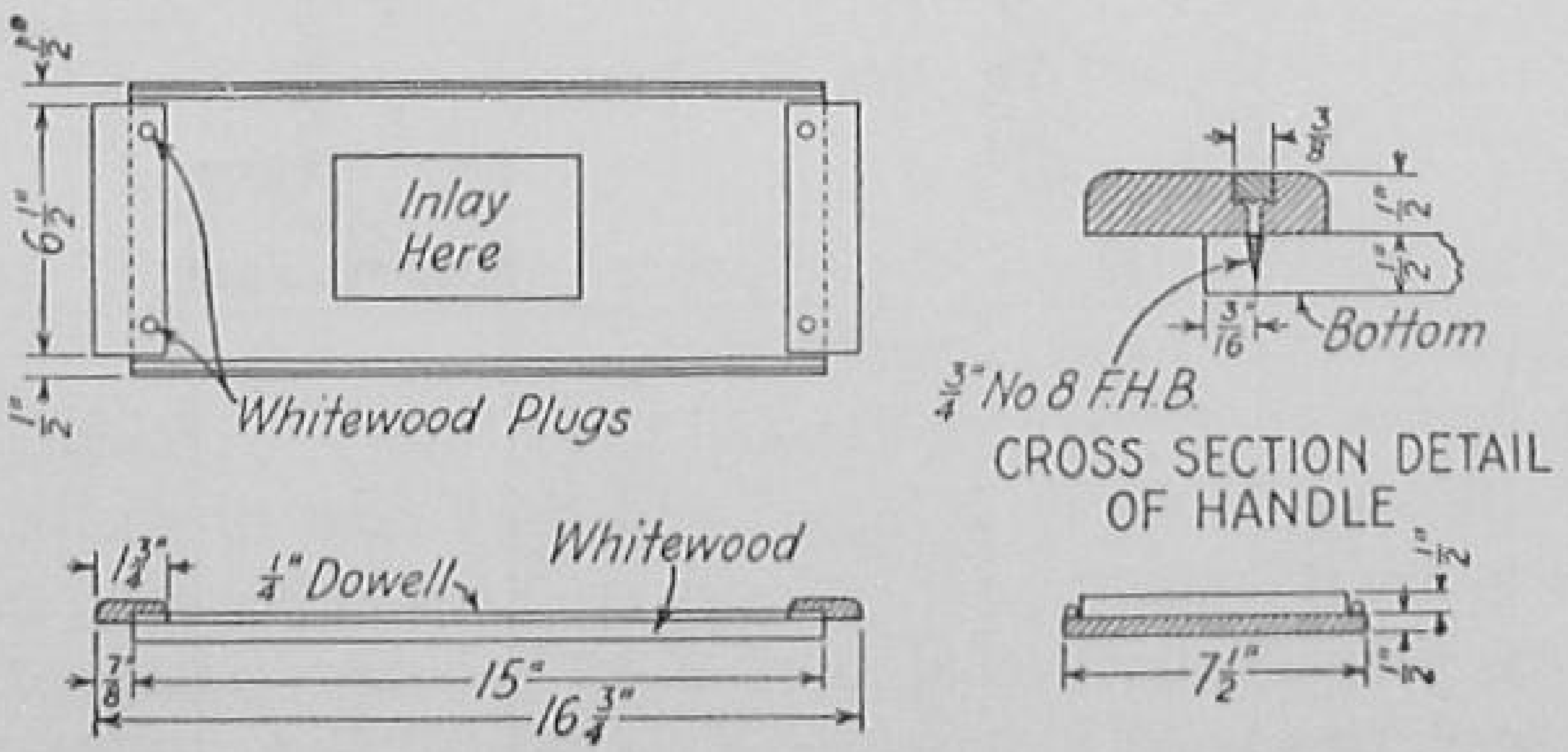


Fig. 102. Drawing of tray No. 2.

4. Cut two pieces of ¼″ dowel rod 12½″ long and, with the plane, flatten one side so that the pieces of dowel will lie flat on the base of the tray.

5. Decorate the surface of the base.

6. Sand all parts with 2/0 sandpaper.

7. Lay out and drill the holes for the screws for fastening the handles. A slightly different method of boring the holes and fastening the handle is used on this tray. After the positions of the holes are marked off, holes are

bored halfway through the handles with a 3/8″ auger bit. This is called counterboring. In the center of this hole drill the screw hole. No countersinking is necessary as the head of the screw will set well down in the counterbored hole. Mark off the location of the screw holes in the base, drill the holes and fasten. After the screws are set, cut plugs from a 3/8″ dowel rod and glue them in the counterbored holes, covering the head of the screw.

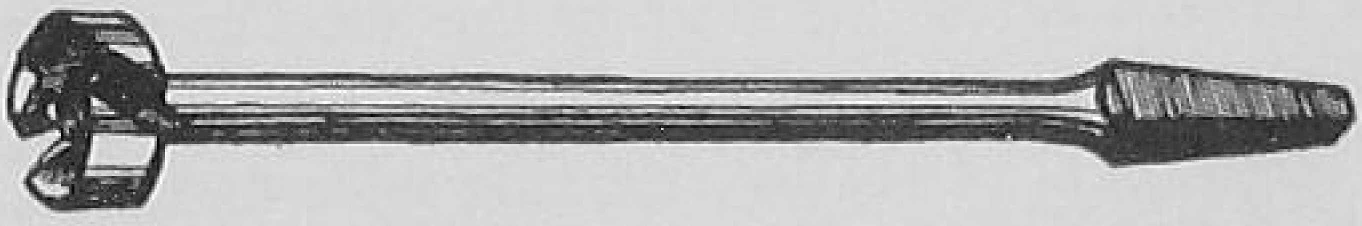


FIG. 103. Forstner bit.

If available, the forstner bit (Fig. 103) is better for making a counterbored hole than is the auger bit. When counterboring a hole in a piece of wood as thin as the tray handles with an auger bit there is some danger that the threaded portion of the bit may come through the wood, which is not desirable in this case (Fig. 104).

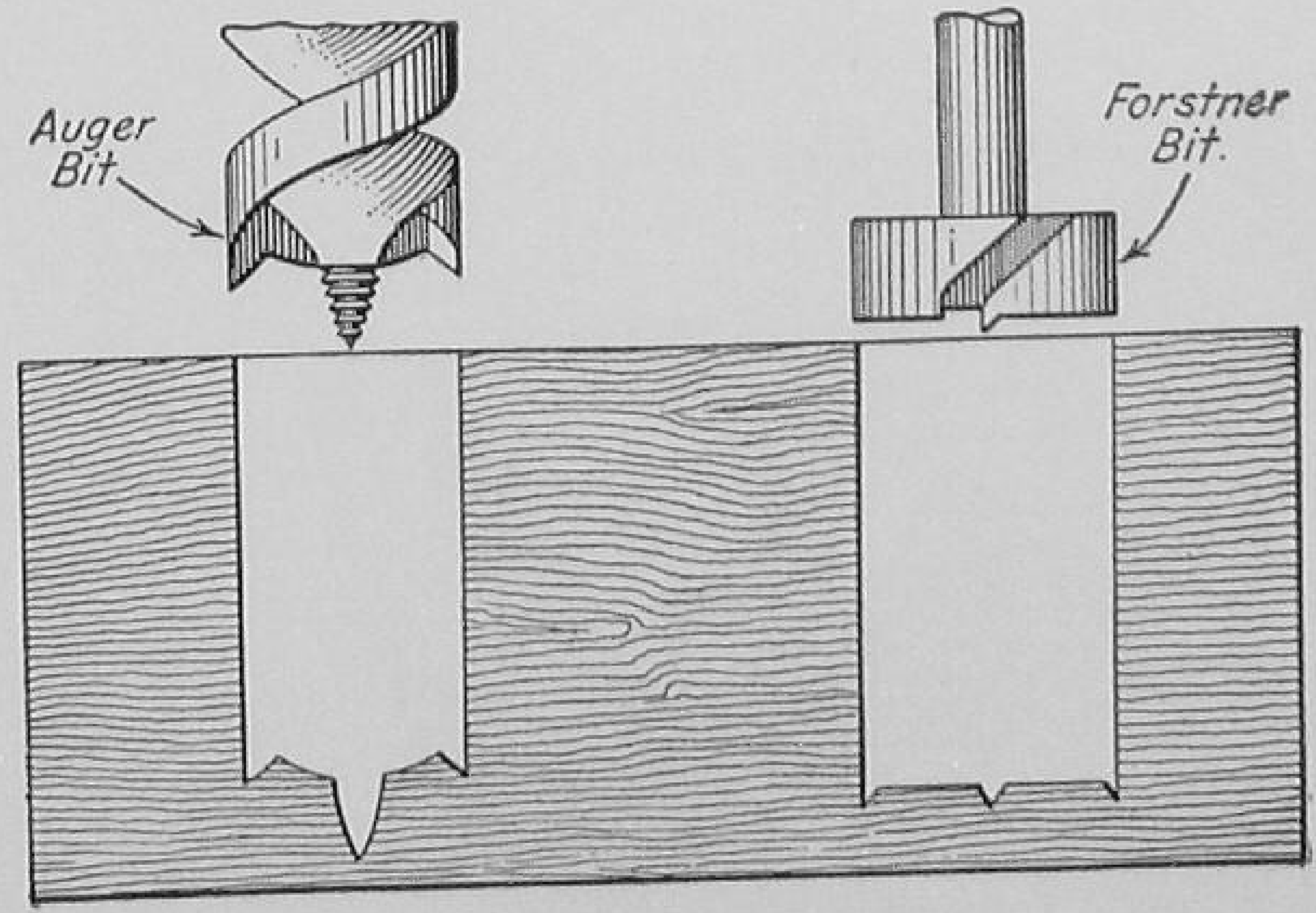


FIG. 104. Use Forstner bit when boring nearly through stock.

8. Fasten the pieces of dowel rod on the edges of the tray as shown in the drawing. Dowel rod is usually made of a hardwood such as maple or birch and if nails are driven directly into these thin rods they may split. Mark off, with a pencil, five spaces for locating nails. Either small brads, 1/2″, No. 18, or brass escutcheon pins of the same size may be used for

fasteners. The escutcheon pin has a larger head than a brad and is more decorative on this job. With a pair of pliers, clip the head from a brad or escutcheon pin of the same size to be used in fastening the dowel rod. Place the clipped end in a drill stock and drill holes through the dowel rod at the places marked. The brads or escutcheon pins may now be driven in these holes without danger of splitting the dowel rod.

9. Sand the entire tray carefully and thoroughly with 4/0 sandpaper. Be careful not to sand across the grain of the wood as scratches thus made will be conspicuous when the finish is applied.

10. Apply three coats of shellac, rubbing with fine steel wool between each coat. The final coat is rubbed with pumice stone and linseed oil, or rubbing oil, then rubbed with rottenstone and oil. Clean off the abrasive material with naphtha or benzine, and then wax the entire job with paste wax.

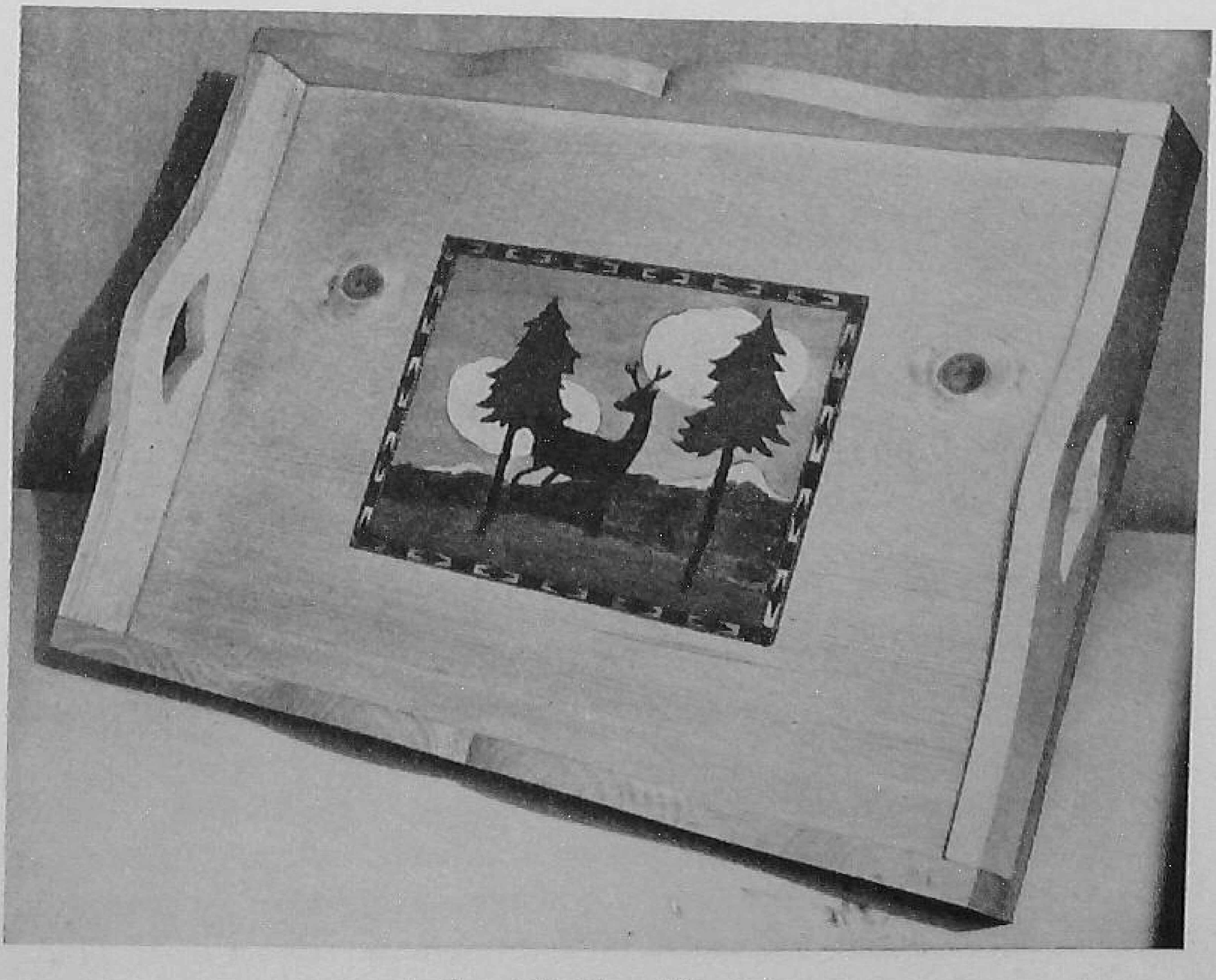


FIG. 105. Tray No. 3.

Tray No. 3

1. Get out rough sizes of stock, using pine, basswood, mahogany, walnut, or other available wood. Rough sizes are as follows:

  1 piece ¾″ x 11½″ x 16½″ for the bottom
  2 pieces 3/9″ x 2″ x 16½″ for the sides
  2 pieces 3/9″ x 2½″ x 10½″ for the ends

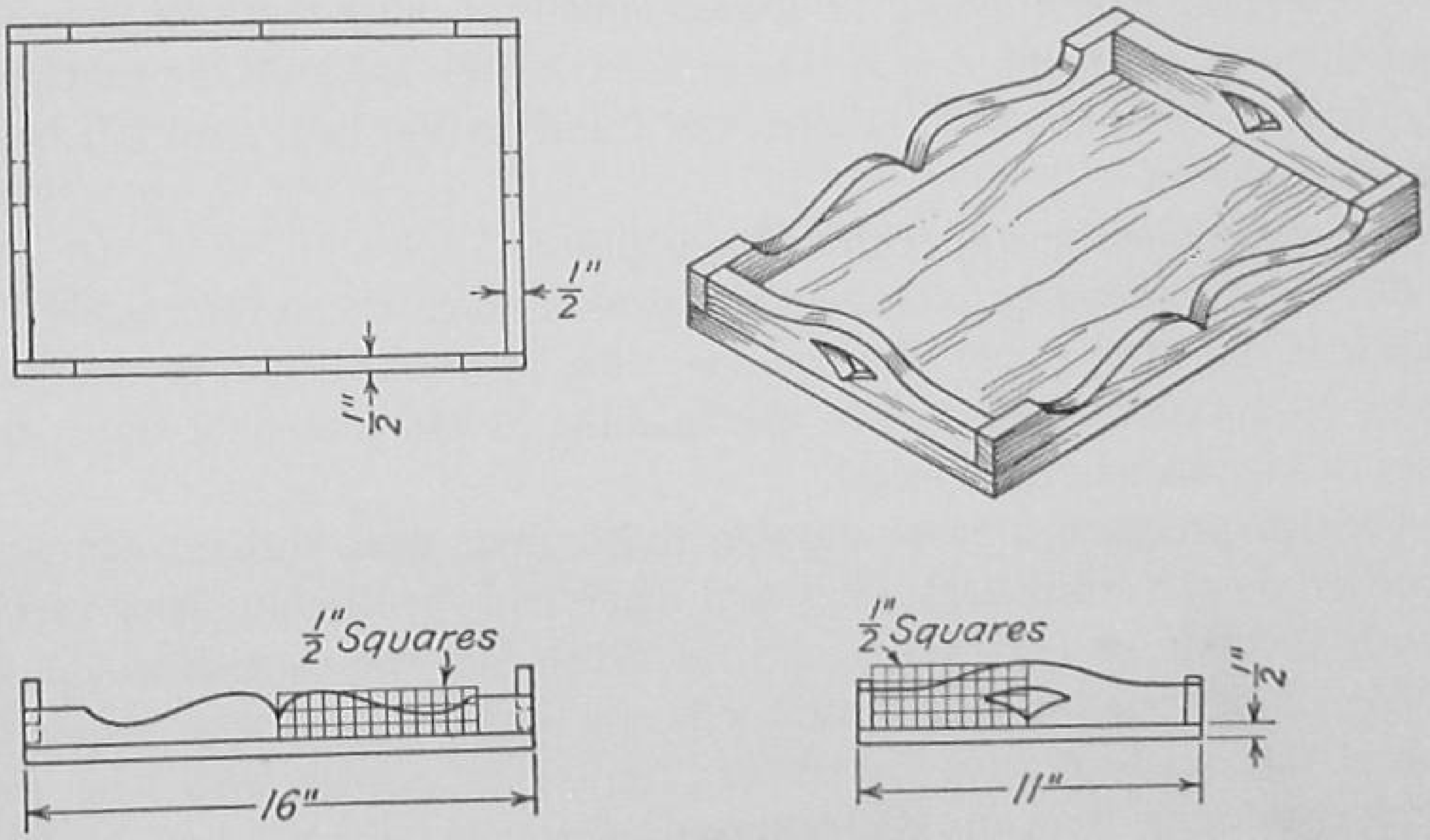


FIG. 106. Drawing of tray No. 3.

2. Square the bottom to finished dimensions, ½″ x 11″ x 16″
   Square the sides to finished dimensions, ½″ x 1½″ x 16″
   Square the ends to finished dimensions, ½″ x 2″ x 10″

3. On a piece of stiff paper, draw the patterns for the sides and the ends as shown in the drawing. Cut out the patterns with scissors and transfer the design to the sides and the ends.

4. With a coping saw cut out the designs for sides and ends. Smooth all saw cuts with a half-round wood file.

5. Apply decoration to bottom of tray.

6. Sand all parts with 2/0 sandpaper.

7. Assemble the sides and ends thus making a frame. Apply glue to the end grain of the end, or handle pieces, and fasten the sides with 1″, No. 16 brads. The heads of the brads are set below the surface of the wood with

a nail set (Fig. 107). After setting, the nail holes can be filled with plastic wood or other type of filler.

FIG. 107. Nail set.

8. On the underside of the tray bottom drill and countersink holes for No. 6 screws. These should be spaced equally, having three on each side and three on each end. Locate the position of the holes on the bottom of the frame with a bradawl. Fasten the frame to the base with 1″, No. 6 flathead screws.

9. Sand the entire tray with 4/0 sandpaper.

10. Dust thoroughly and apply a coat of shellac. When thoroughly dry, rub with fine steel wool. The tray can then be finished with several more coats of shellac as described in the finishing of the preceding trays, or a coat of varnish may be applied.

Varnish produces a more durable finish than does shellac. Obtain a good grade of varnish and use a well made and thoroughly clean varnish brush about 1″ or 1½″ wide. Dip the brush into the varnish to the full length of the bristles, then draw the brush lightly over a wire bar at the top of the can to remove the excess. Apply the varnish with long, even strokes working from the center toward the ends. From 12 to 24 hours should be allowed for drying, then rub the entire job with 8/0, wet-dry sandpaper moistened in rubbing oil. Rub with pumice stone and oil, then with rottenstone and oil until a smooth satin finish has been obtained. The finish may then be protected further by applying a coat of paste wax.

It is not advisable to attempt a varnish finish unless a dustproof room is available for the varnish application. Varnish dries more slowly than shellac and dust will adhere to the newly varnished surface resulting in a rough, pitted finish. Varnish brushes should be cleaned thoroughly with turpentine.

Photo Album

1. Using a crosscut saw, cut two pieces of ¼″ plywood approximately 9½″ wide and 12″ long.

2. As plywood is already surfaced, it is not necessary to plane a working face or to plane the boards to thickness. Plane an edge and end on each piece, then square to 9″ wide and 11½″ long.

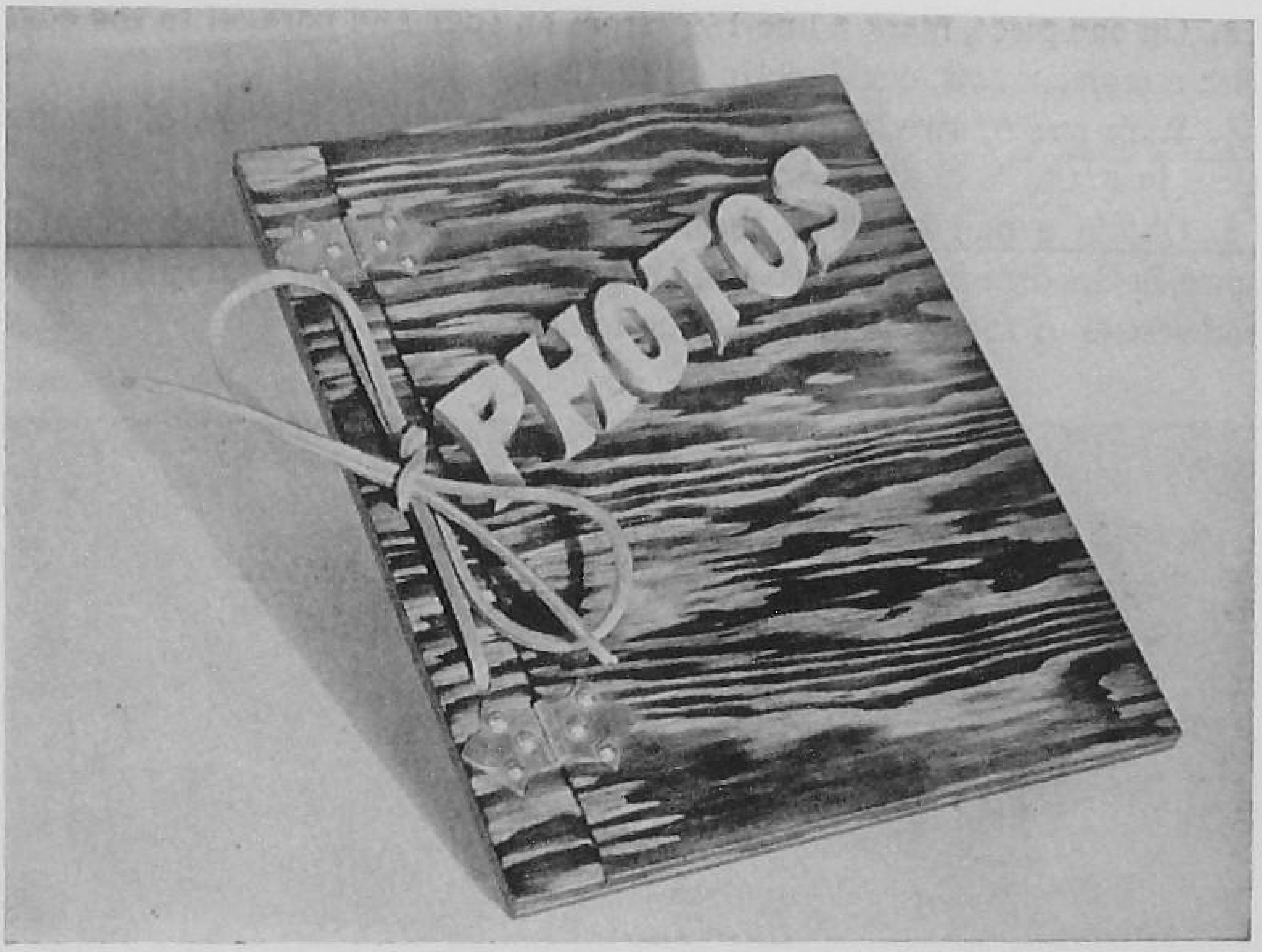


Fig. 108. The photo album.

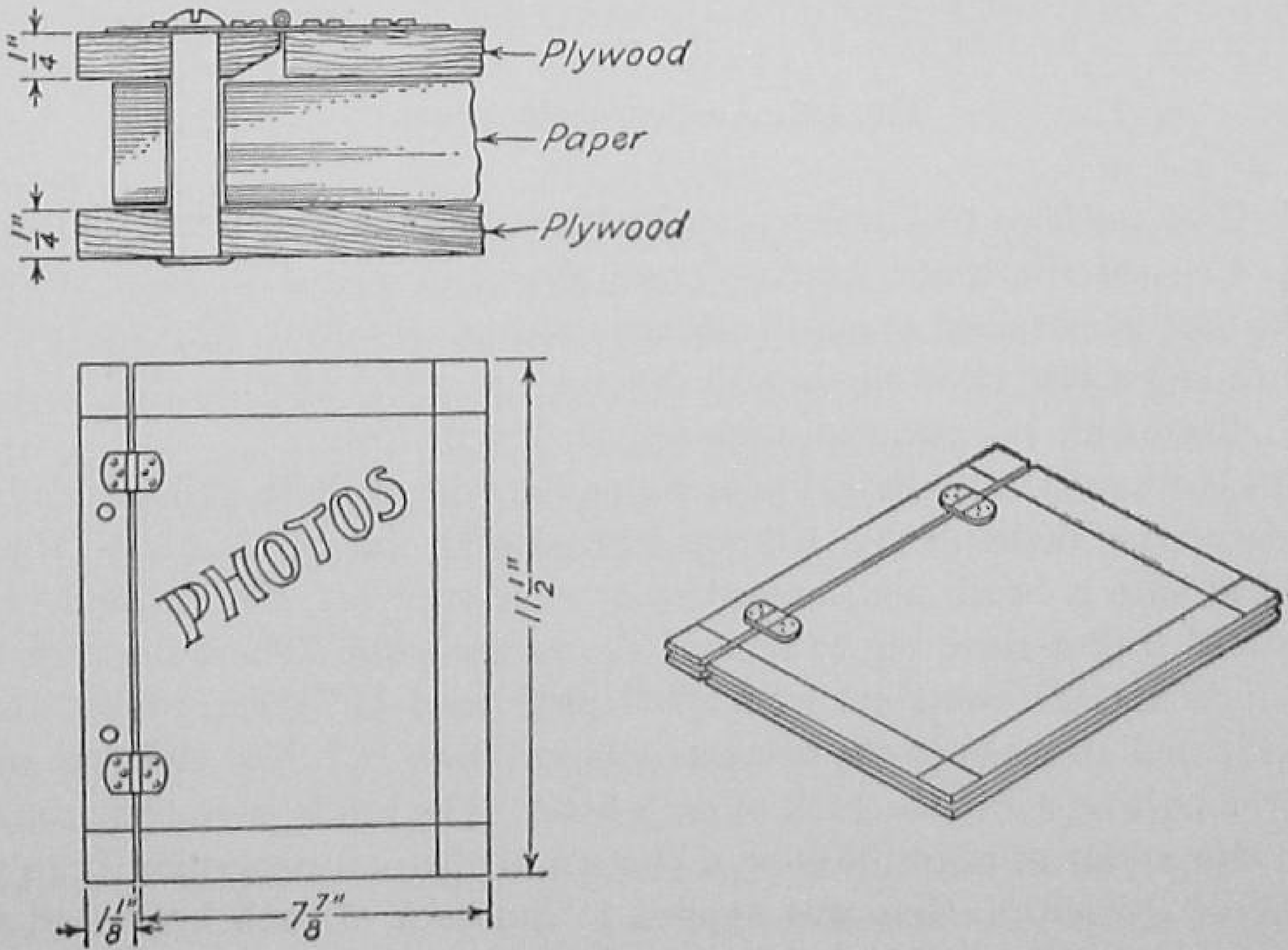


Fig. 109. Drawing of the photo album.

3. On one piece, mark a line 1¼″ from an edge and parallel to the edge. With a crosscut saw, cut directly on the line.

4. With one or two strokes of the plane, smooth the edges of the two pieces just cut.

5. Obtain a pair of small chest or cabinet hinges and locate them as shown in the drawing. Fasten the hinges with ¼″, No. 4 flathead or oval-head screws of the same finish as the hinges.

FIG. 110. Another photo album.

6. Two methods of binding may be used: the rawhide thong shown in Fig. 108 and the ledger binding posts shown in Fig. 110. The binding posts may be obtained at most stationery stores. Bore two $\frac{3}{16}$″ holes with a drill and drillstock in the location shown on the drawing.

7. Sand with 2/0 and then with 4/0 sandpaper.

8. The handicrafter should now decide the type of finish and the method of decorating desired. Fig. 108 was stained with walnut oil stain. This is applied with a brush and, immediately after applying, the entire surface is wiped with a clean rag to remove the excess stain. The letters for the word "PHOTOS" were cut from white pine wood ¼″ thick, sanded thoroughly and attached to the cover as follows: Two ⅜″, No. 18 brads were driven part way into the back of each letter. The heads were then clipped off with a pair of pliers, leaving a portion of the nail projecting from the back of the letter. Glue was applied to the back of each letter and the letter was then pressed into the cover, forcing the end of the nails into the

plywood. The entire project was then given a shellac finish as explained in the finishing of the tray.

Fig. 110 was decorated by tracing the design for the picture and the letters onto the plywood, using tracing and carbon paper. An electric pencil was used to burn the outlines and the details of the figures and to block-in the letters. The outlines of the figures were then colored with enamel. When this was thoroughly dry, the entire job was given a shellac finish.

The size of the album may be made to suit the individual's desires and to accommodate various standard sizes of scrapbook or photo-album paper.

Jewel Box

1. Obtain some hardwood, such as maple, cherry, walnut, or mahogany, ½ inch thick. Cut the rough dimensions as follows:
   - 2 pieces ½″ x 5½″ x 9″—top and bottom
   - 2 pieces ½″ x 3″ x 4⅝″—ends
   - 2 pieces ½″ x 3″ x 8½″—sides
2. Plane a face, edge and end on each piece, then square the pieces to the following dimensions:
   - 2 pieces ⅜″ x 5″ x 8½″—top and bottom
   - 2 pieces ⅜″ x 2½″ x 4⅛″—ends
   - 2 pieces ⅜″ x 2½″ x 8″—sides

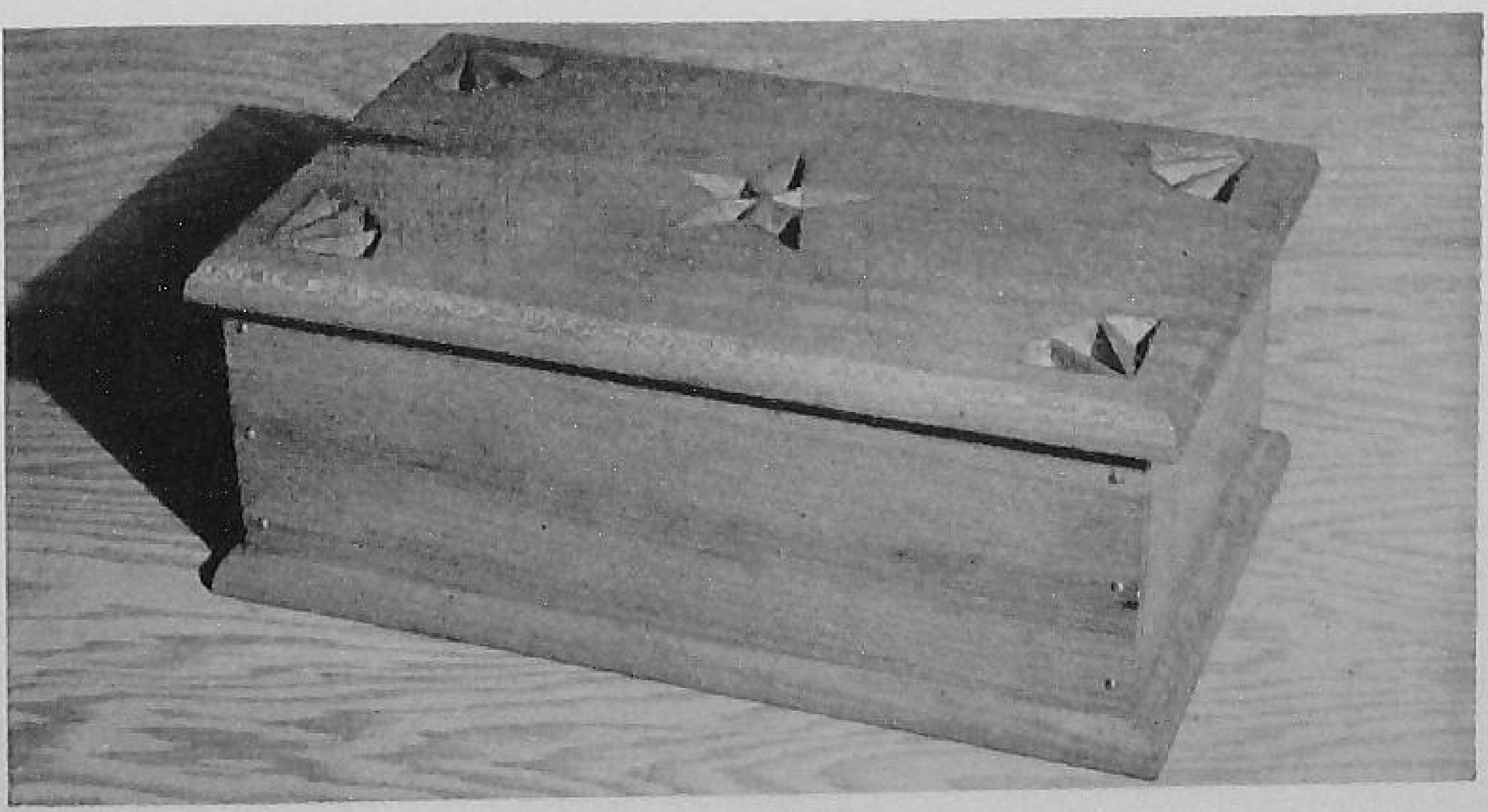


FIG. 111. A jewel box.

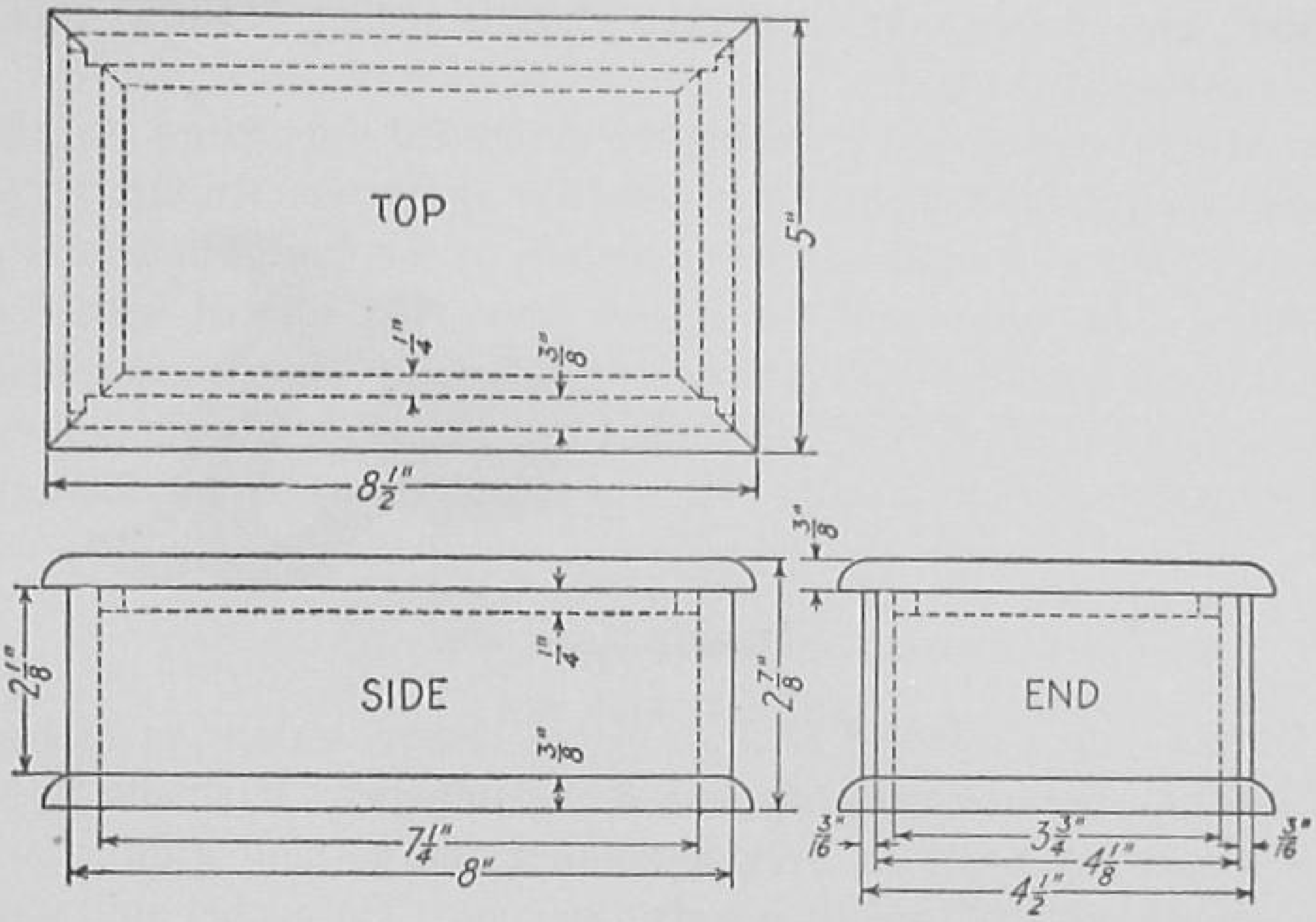


Fig. 112. Drawing of jewel box.

3. Lay out a design for chip-carving the cover and proceed with the carving (see Chapter V). An inlay, a burned design, or other decoration may be used.

4. Round the edges of the top and bottom as shown in the drawing, using a plane.

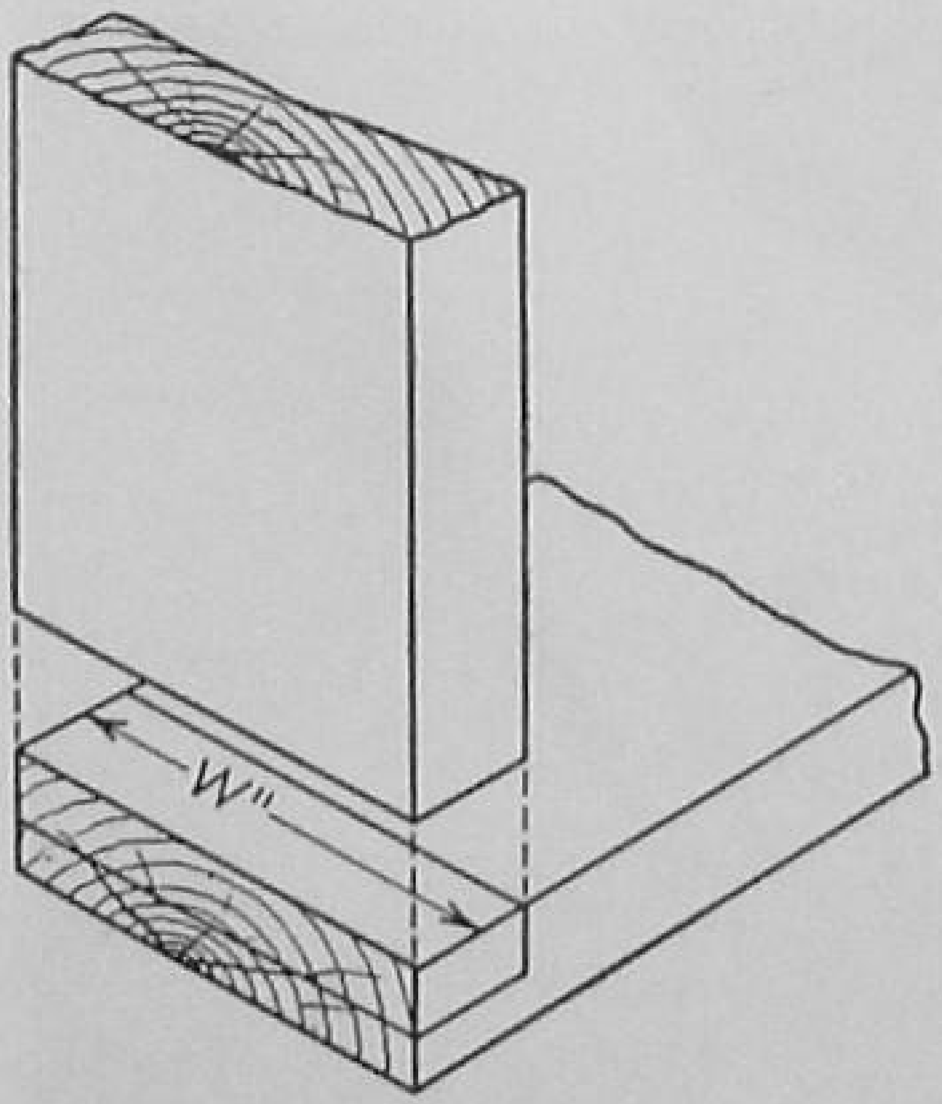


Fig. 113. Layout of rabbet joint.

5. This box is constructed with a rabbet joint at the corners. On the two side pieces measure in from each end ⅜″ (or the thickness of the end pieces) and square a line across the board at this distance. Continue the line across the edges of the board. Set the marking gage at 3/16″ (or one half the thickness of the piece), and from the surface on which the line has been drawn, gage a line across the ends of the pieces. Continue the lines along the edges so that the layout for the joint looks like Fig. 113. The two ends of both side pieces are laid out at the same time.

6. A backsaw (Fig. 114) is used for cutting out the joint. Clamp the wood to the bench as shown in Fig. 115 and saw just outside the line as deep as the depth line. Next clamp the piece in the vise as in Fig. 116 and saw just inside of the gage line until the piece of waste stock is removed.

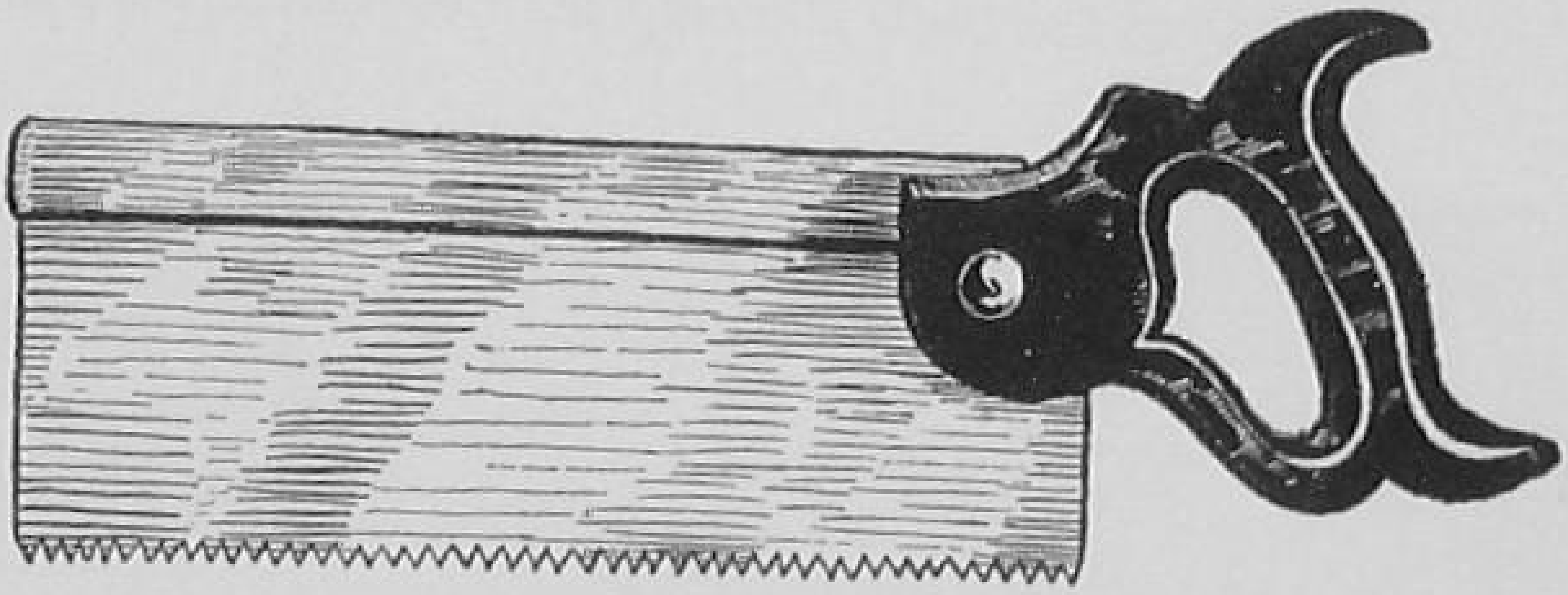


FIG. 114. Back Saw.

7. Sand all pieces thoroughly with 2/0 sandpaper. It should be noted that there are two types of sandpaper—flint and garnet. Flint is a light, rather grayish color and garnet is a reddish color. The garnet appears to be more durable and gives longer service. Sandpaper is graded in various degrees of coarseness ranging from 8-0 (very fine, used for finishing) to No.

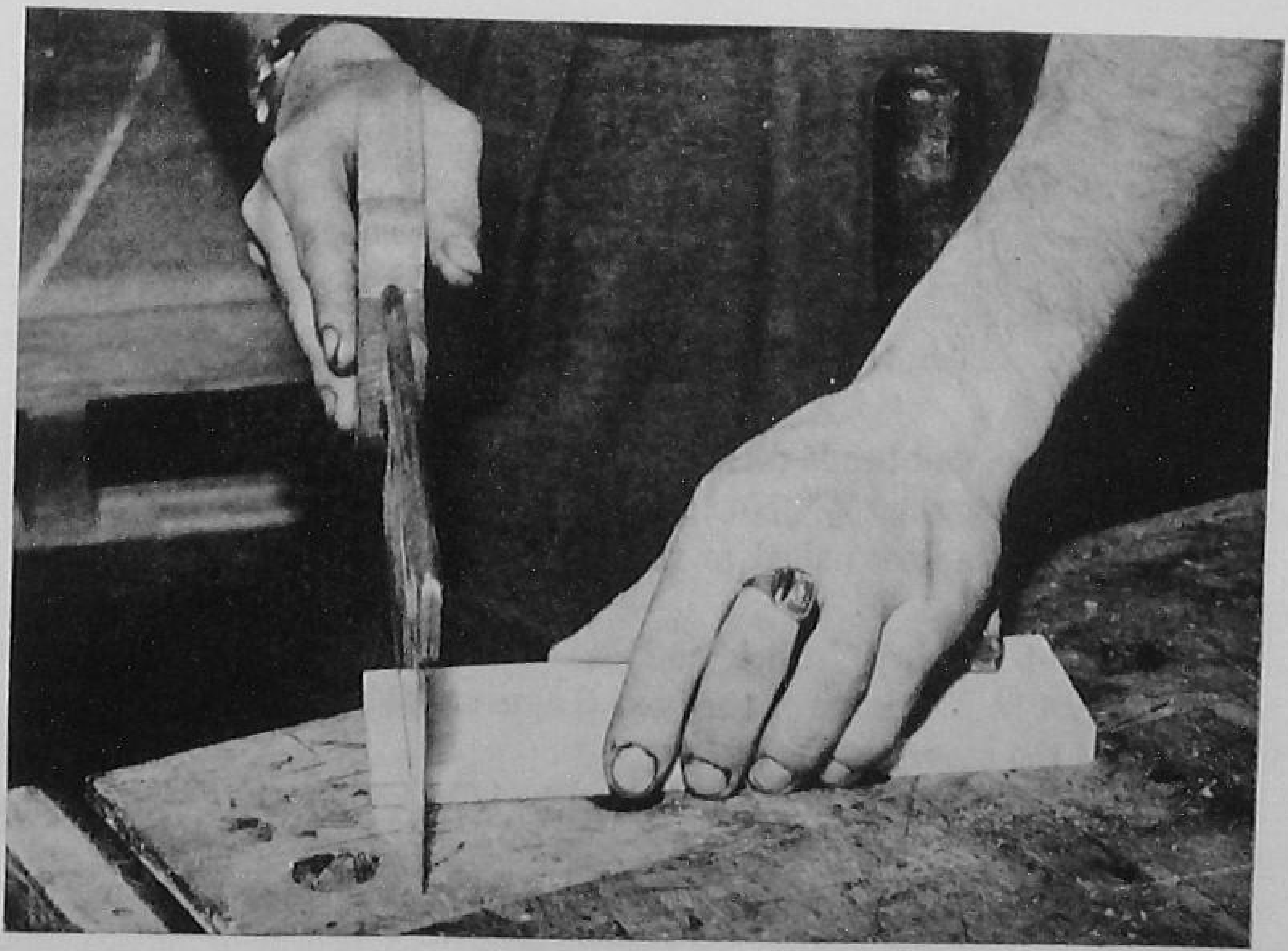


FIG. 115. Sawing the shoulder of a rabbet.

3 (very coarse). Sizes Nos. ½, 0, or 2/0 are commonly used for first sanding and Nos. 3/0 and 4/0 for preparing the surface just before finishing.

8. The box is now ready for assembling. The box shown in Fig. 111 was assembled with glue and ½", No. 16 brass escutcheon pins were driven into the sides, the heads of the nails showing for decorative purposes. If it

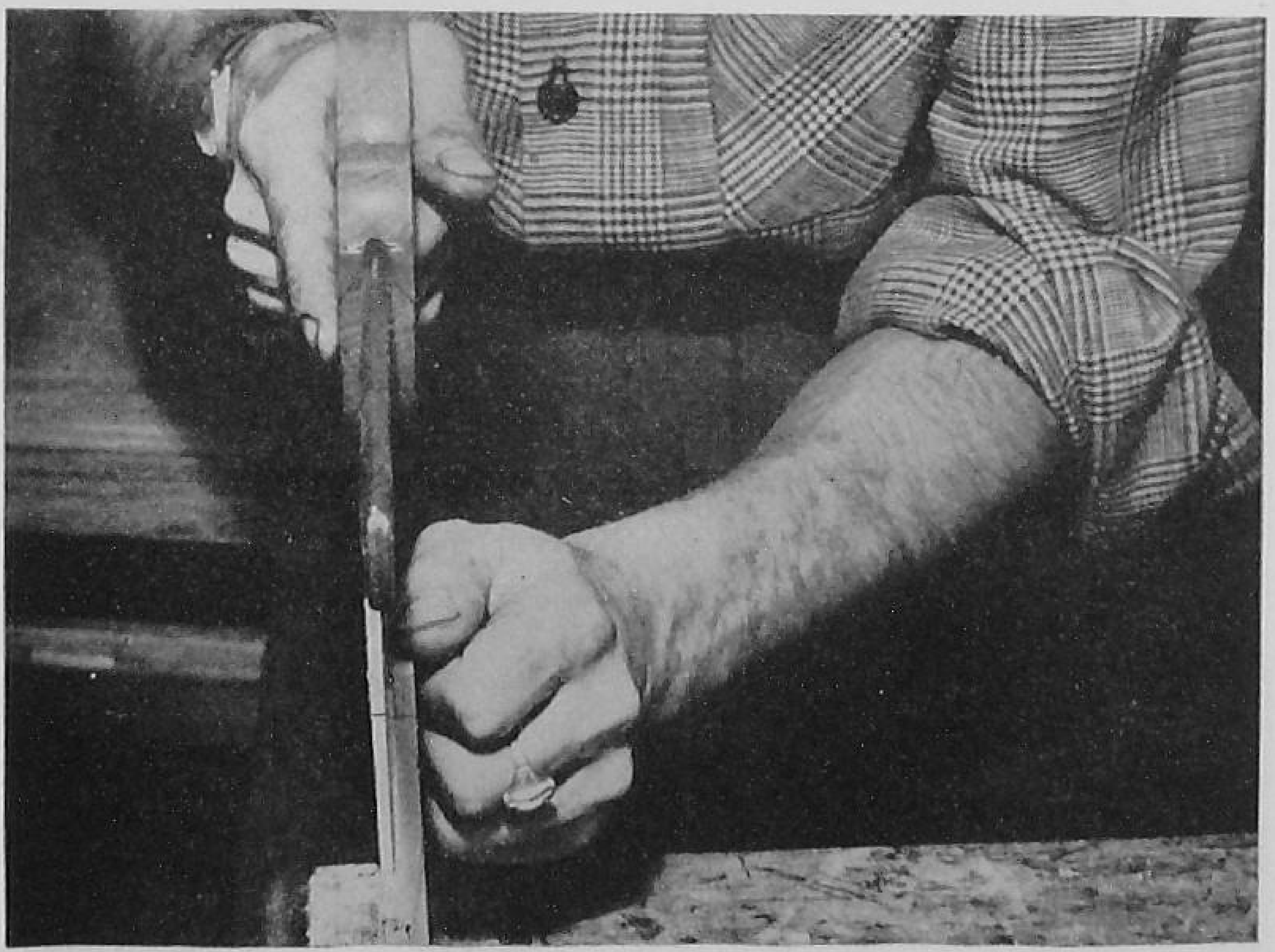


FIG. 116. Sawing the cheek of a rabbet.

is desired that the nail heads do not show, the box should be assembled as shown in Fig. 117, using ½", No. 16 brads.

9. The bottom is now nailed to the sides and ends, using ¾", No. 16 brads.

10. Strips of wood ¼" thick and ¾" wide are cut and the corners mitered to just fit the inside of the box. These strips are now nailed to the underside of the cover.

11. The entire box is now sanded with 4/0 sandpaper, dusted thoroughly, and then finished.

12. If a close-grained wood such as maple or cherry is used, the method of finishing is the same as that for the projects described prior to this box. If an open-grained wood such as walnut or mahogany is used, it is neces-

sary to first fill the pores of the wood with a silex paste filler. This may be obtained in natural color or in such colors as walnut, mahogany, etc. The paste is thinned with turpentine to the consistency of whipping cream; it is then applied with a stiff paintbrush. After several minutes, the filler will lose its gloss. At this stage, the filler is rubbed into the grain of the wood with a piece of burlap or coarse cloth; the rubbing is done across the grain. Rub off the excess filler being sure to pick it carefully from corners. The filler should now be allowed to set for 48 hours after which a coat of shellac is applied and the finishing process is continued as with the other projects.

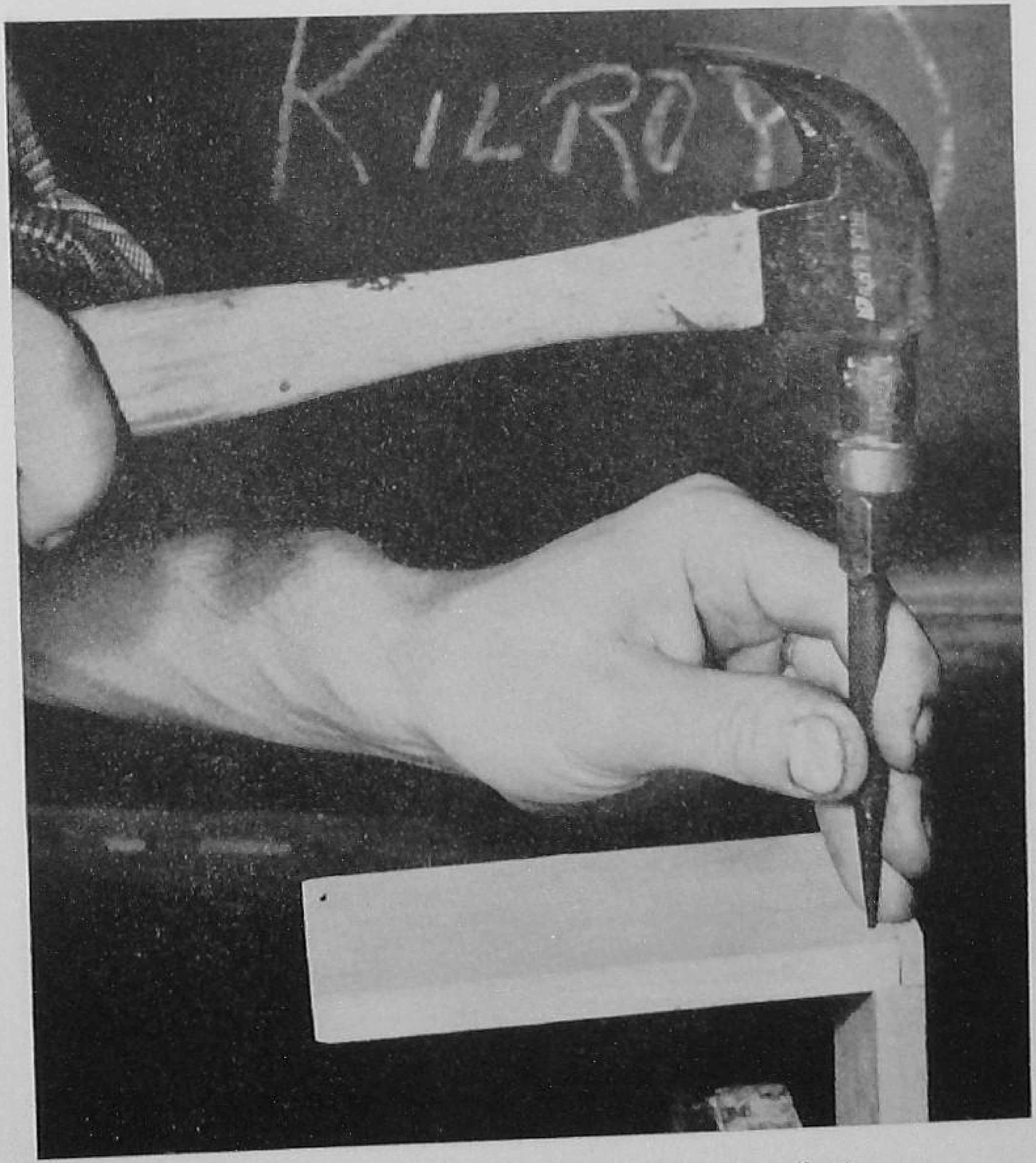


FIG. 117. Assembling a rabbet joint—use of a nail set.

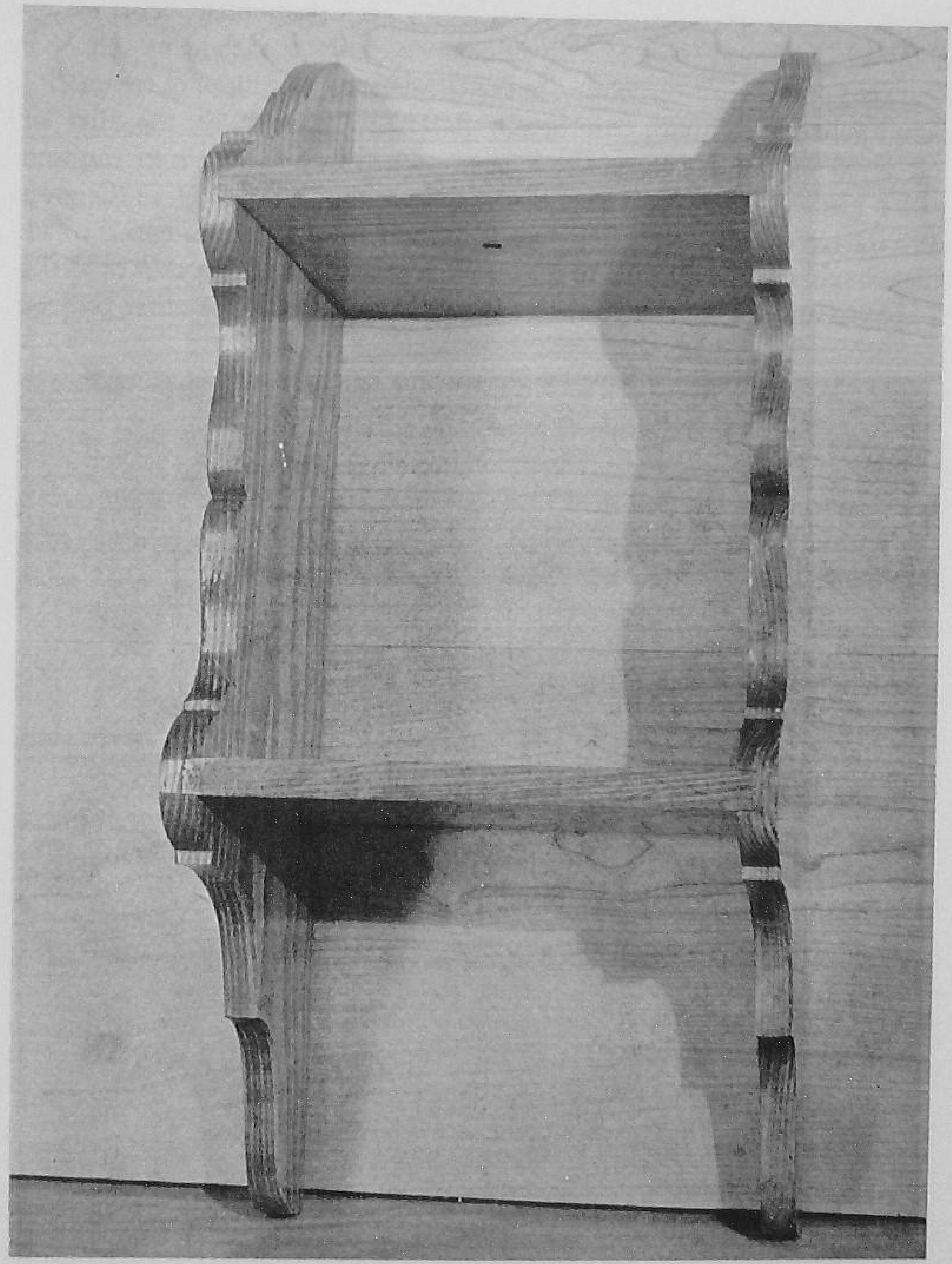


FIG. 118. The wall shelf.

Wall Shelf

1. Make a pattern for the sides of the wall shelf, using 1″ squares as shown in the drawing.

2. Cut out two pieces of white pine ½″ thick (surfaced), 6½″ wide, and 18½″ long for the sides. Cut out two pieces ½″ thick, 6½″ wide and 9″ long for the shelves.

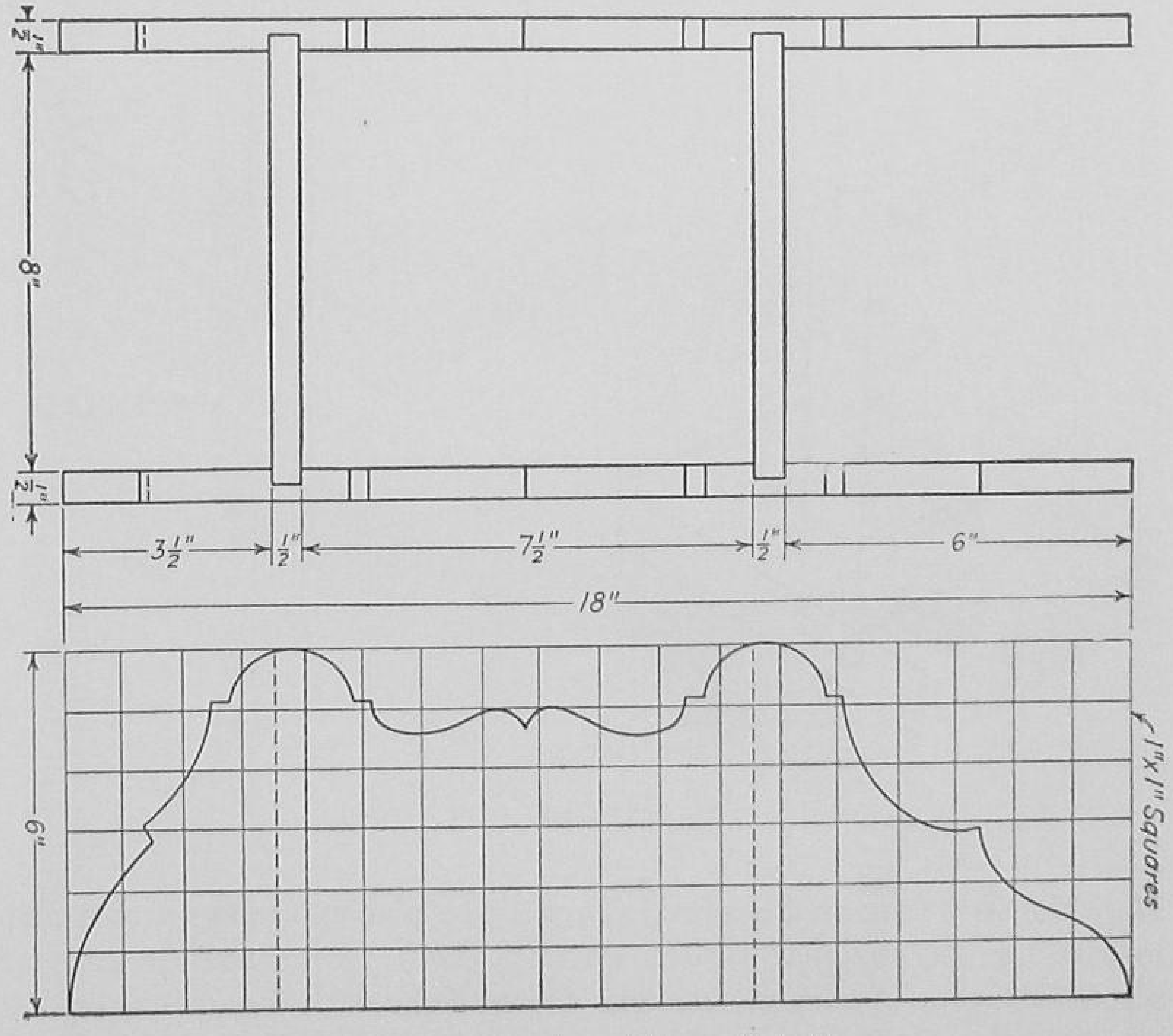


FIG. 119. Drawing of the wall shelf.

3. On the side pieces, plane a working edge square with the face.

4. Square the two shelves by planing a working edge, working end, then square to length (8½″). Next square to width (6″).

5. Trace the design on the two side pieces, holding the straight side of the pattern along the working edge of the piece of wood.

6. This project will be assembled by use of a dado joint (Fig. 120). Lay out the dado lines as shown in the drawing. Using the try square held tightly against the working edge, square the lines across the surface of one piece. Make the lines on the surface where the design has been traced.

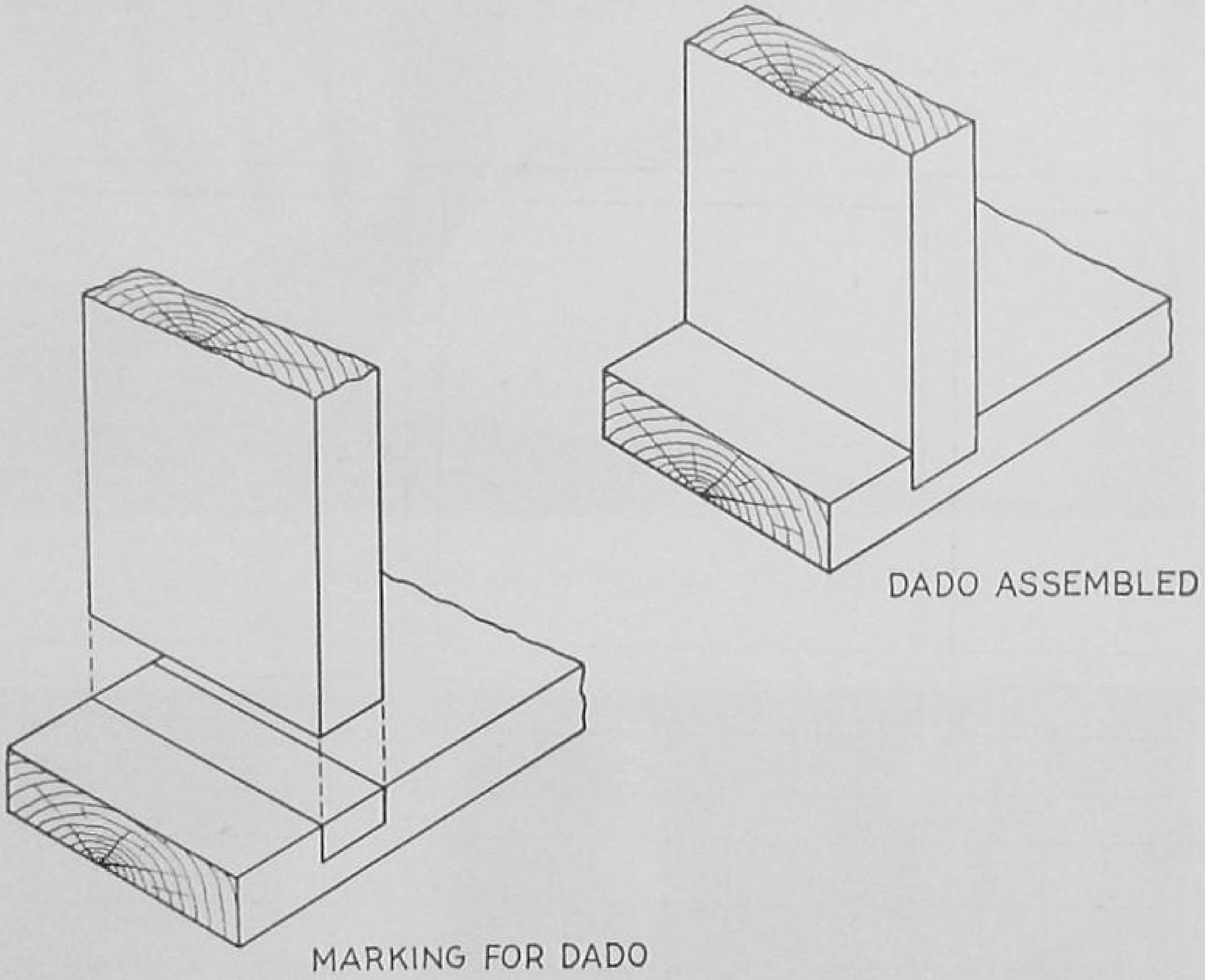


Fig. 120. Dado joint.

Mark the dado lines on the second side piece by placing the two pieces edge to edge and the designed surface up (Fig. 121). The lines are squared across each edge of both pieces. The depth of the dado is now marked off by use of the marking gage; the depth should be one half the thickness of the piece of stock.

7. Using the backsaw, saw just along the lines to the depth line of the dado (Fig. 122).

8. The wood is now removed between the saw cuts with a chisel, as shown in Fig. 123. Care must be taken to keep the hands in back of the cutting edge of the chisel as this is one of the most dangerous of the hand tools.

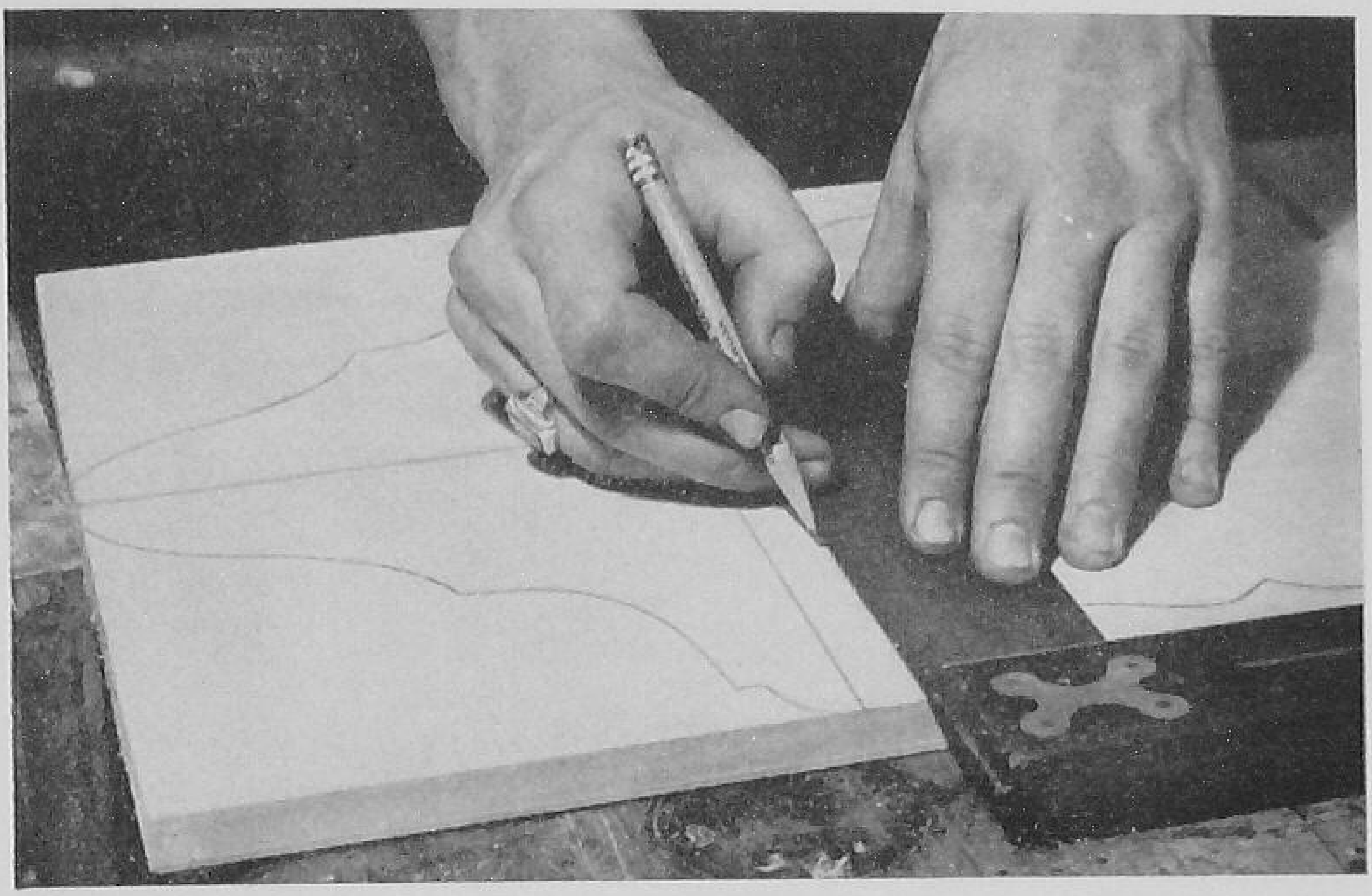


Fig. 121. Laying out the dado lines.

Fig. 122. Sawing the dado.

Types of Chisels. (1) Tang chisel (Fig. 124)—the blade ends as a sharp-pointed shank which is called a "tang." This "tang" is driven into one end of the handle. This end of the handle is protected from splitting by a metal ferrule. This type is usually used for light paring work. (2) Socket chisel (Fig. 125)—the blade ends as a tapered socket into which the tapered end of the handle is driven and held fast by friction. This type chisel may be used for heavy work.

Fig. 123. Chiseling out the dado.

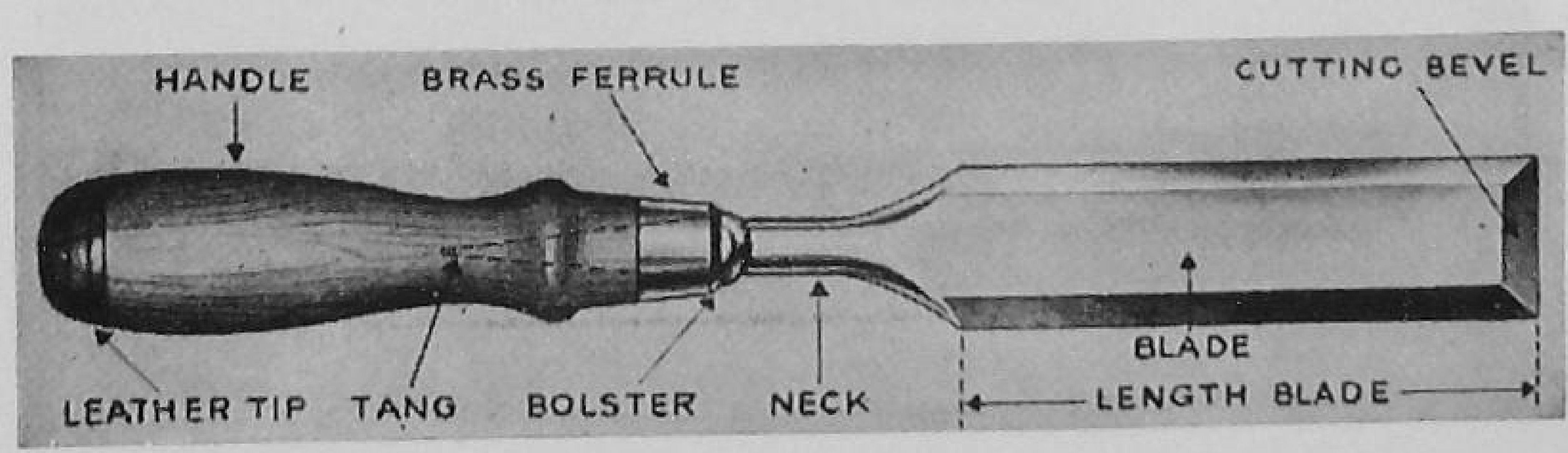


Fig. 124. Tang chisel.

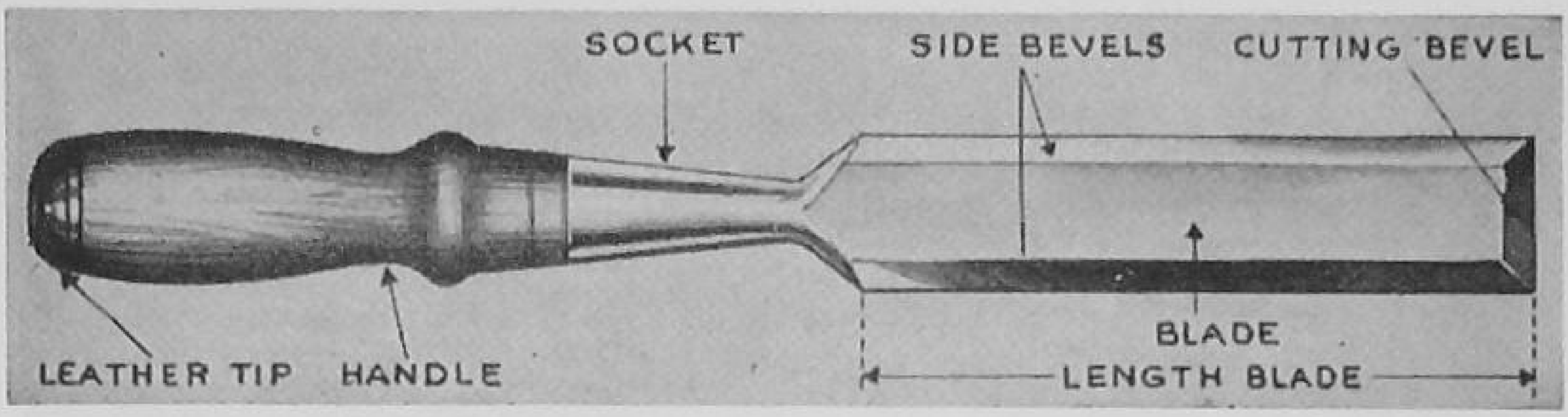


FIG. 125. Socket chisel.

Chisels may be purchased in widths from $\frac{1}{4}''$ to $1''$ by eighths and from $1''$ to $2''$ by fourths. Chisels are sharpened in the same manner as plane irons and should be kept sharp at all times.

If available, a router plane may be used to smooth the bottom of the dado (Fig. 126).

9. Using a coping saw, cut out the design of the sides of the shelf.

10. Smooth the curved edges with a half-round woodworker's file.

11. Smooth all pieces with 2/0 sandpaper.

12. The job is now ready for assembling. Apply glue to the dado and place the shelves in the groove. Drive 1", No. 16 brads through the side pieces and into the shelves (Fig. 127). Be careful that the hammer does

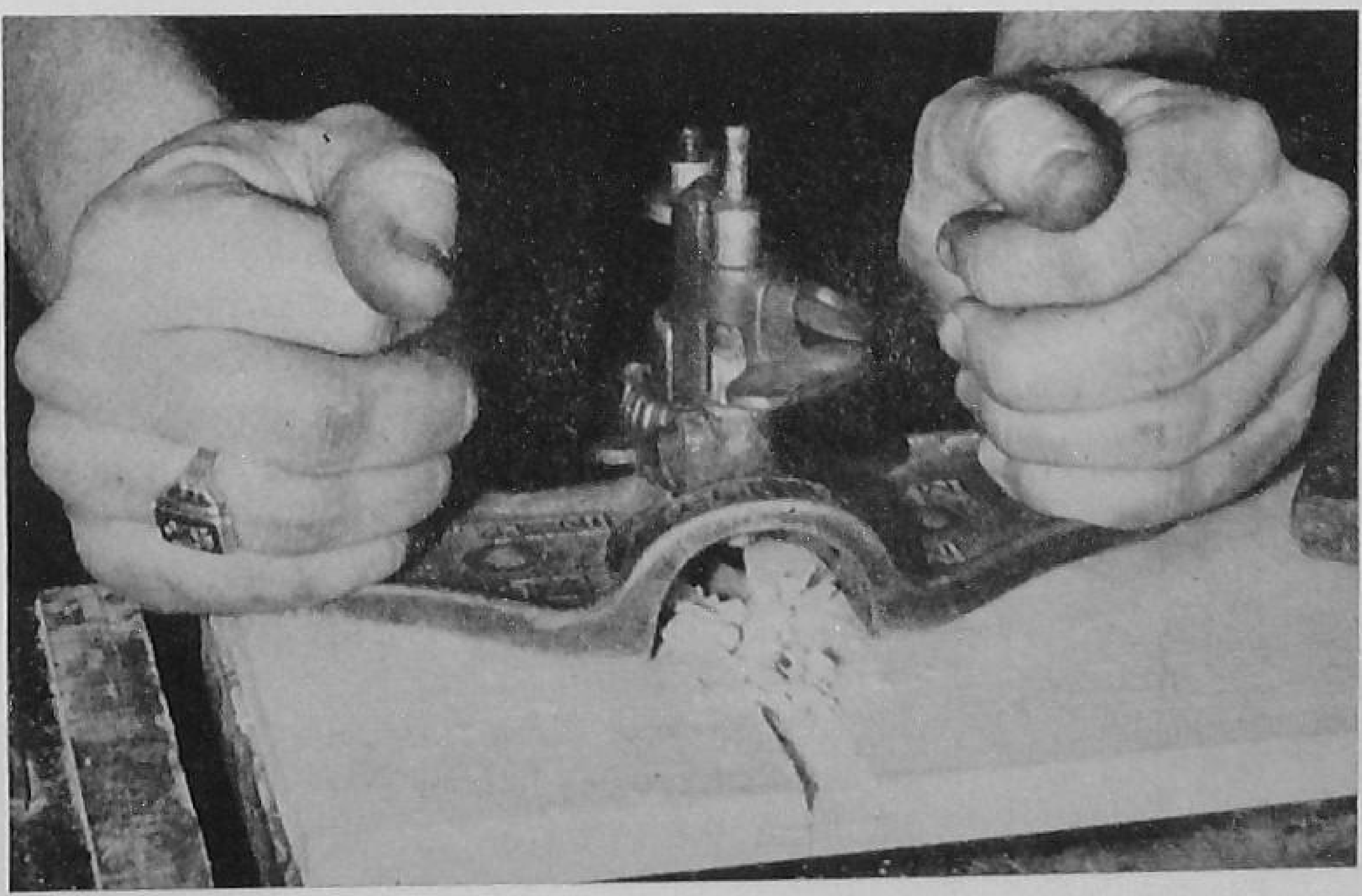


FIG. 126. Using a router plane in a dado.

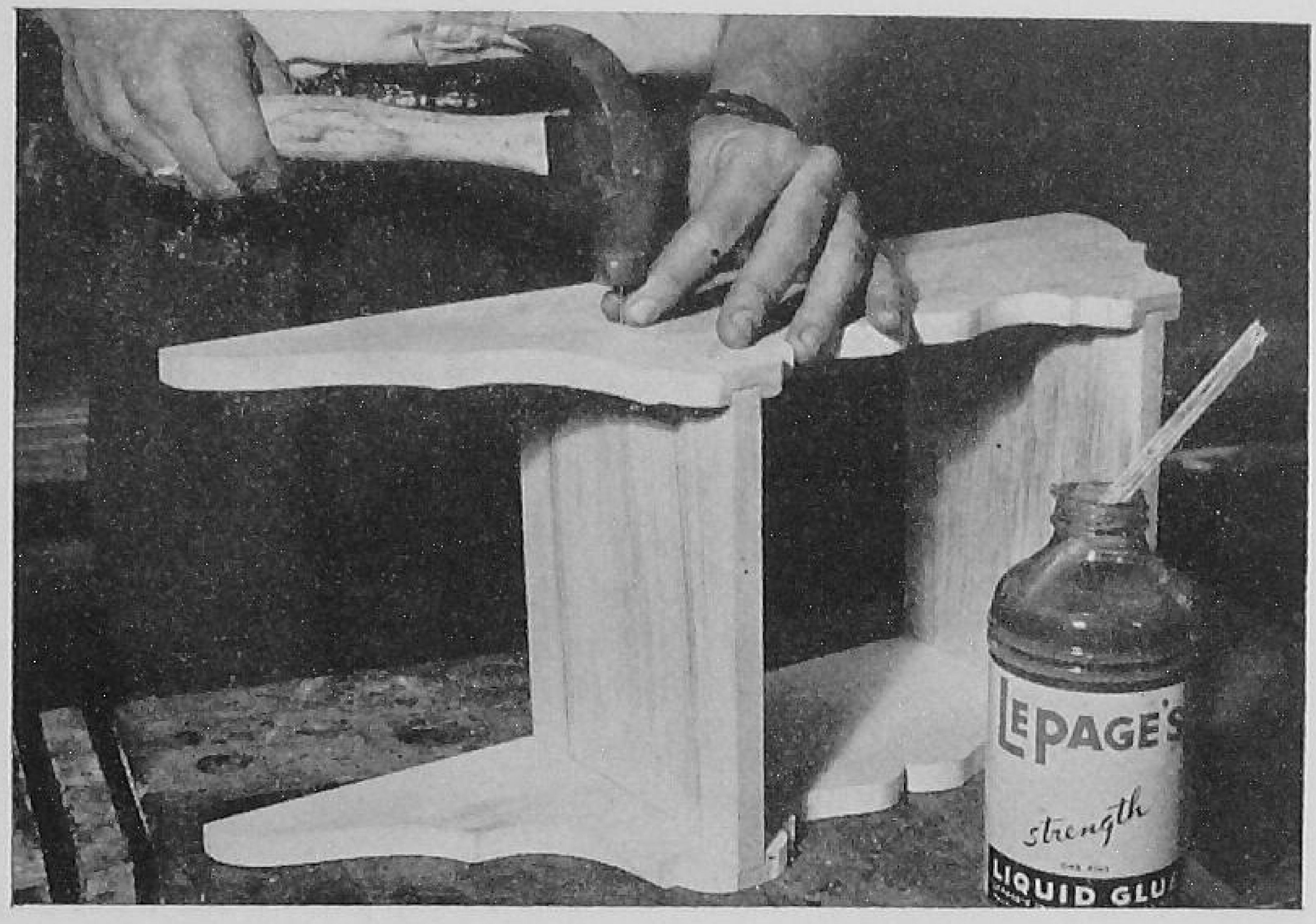


FIG. 127. Assembling the wall shelf.

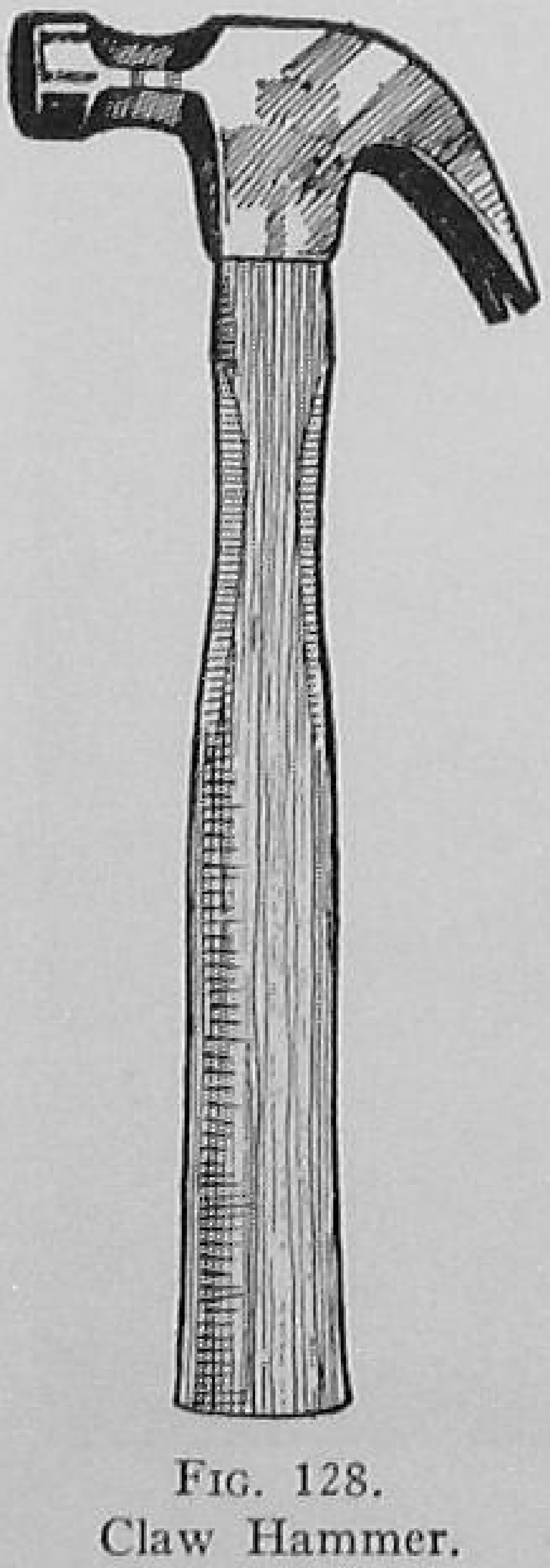


FIG. 128.
Claw Hammer.

not mar the surface. Set the heads of the brads below the surface with a nail-set and hammer.

Brads may be purchased in various lengths and thicknesses. The thickness is denoted by a number which indicates the number, or diameter, of the wire from which the brad is made.

A good grade of claw hammer is made of cast steel, with a striking face on one side and a claw on the other (Fig. 128). There are several patterns of claw hammers, but the two main types are the curved claw, which is the most common, and the straight claw. Hammers vary in weight from 3 oz. to 20 oz., but the 10- or 12-oz. size is the most convenient for all-around work.

13. Fill all brad holes with putty, plastic wood, or some other type of hole or crack filler.

14. Sand the entire project with 4/0 sandpaper and finish as desired in accordance with the methods described under the various projects.

Fig. 129. The pump lamp.

Pump Lamp

1. Obtain a piece of wood and square it to 3/4″ thick, 5 5/8″ wide and 5 5/8″ long. This is to be used as the base.

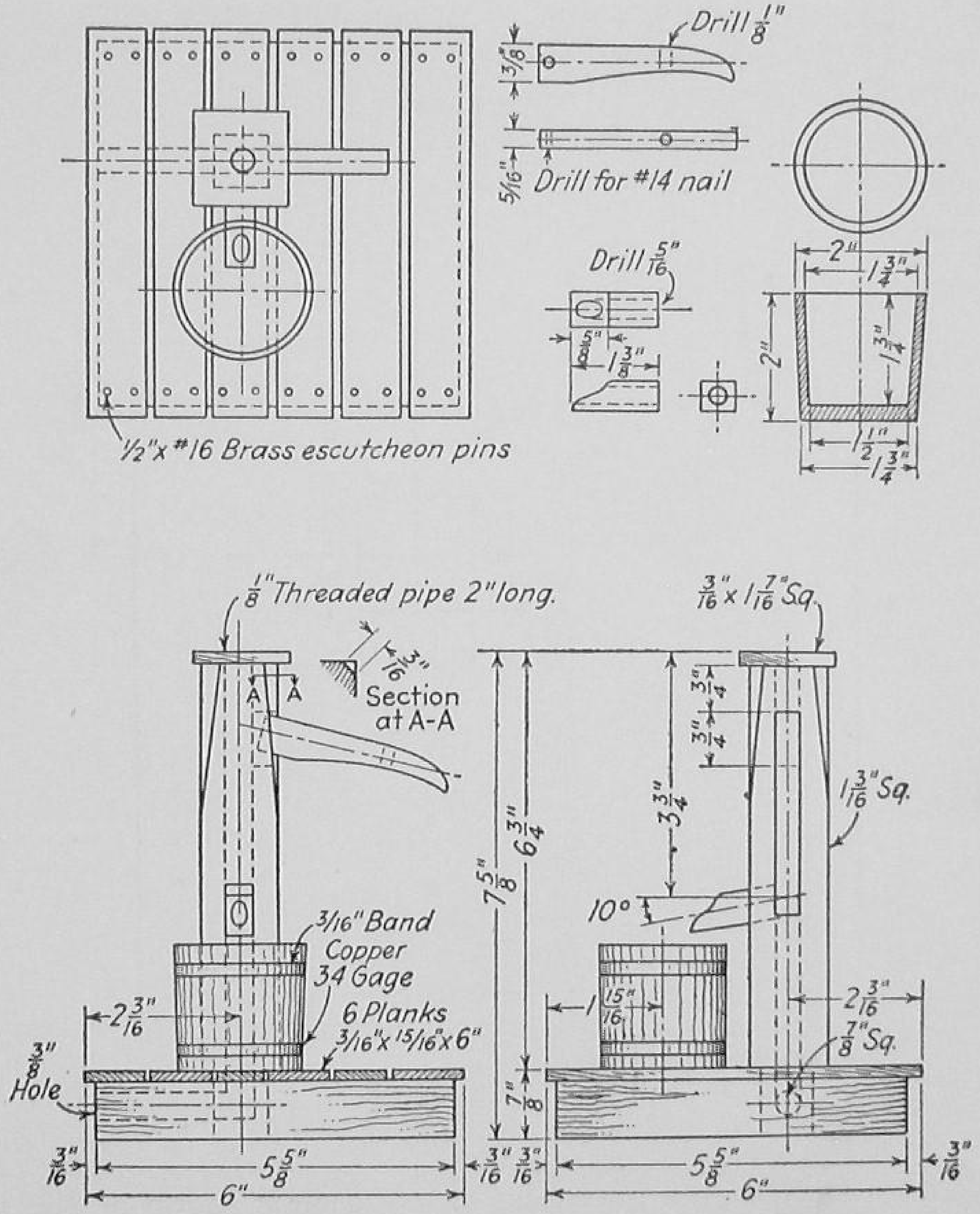


FIG. 130. Drawing of a pump lamp.

2. Square another piece of the same kind of wood to $1\frac{3}{16}''$ thick, $1\frac{3}{16}''$ wide and $7\frac{3}{16}''$ long. This is for the post.

3. The post is fitted to the base by use of a through mortise and tenon joint. This joint is made as follows (make all layout lines with a sharp pencil):

a. On the base piece, lay out the mortise as shown (Fig. 131).

b. With a $1\frac{3}{16}''$ auger bit, bore a hole through the piece in the center of

the 7/8″ square just laid out (Fig. 132). Use the reverse boring method to prevent splitting the wood.

c. With a 3/4″ chisel, cut the hole square to the lines shown in Fig. 133.

d. On the post, lay out the tenon (Fig. 134) using a try square and marking gage.

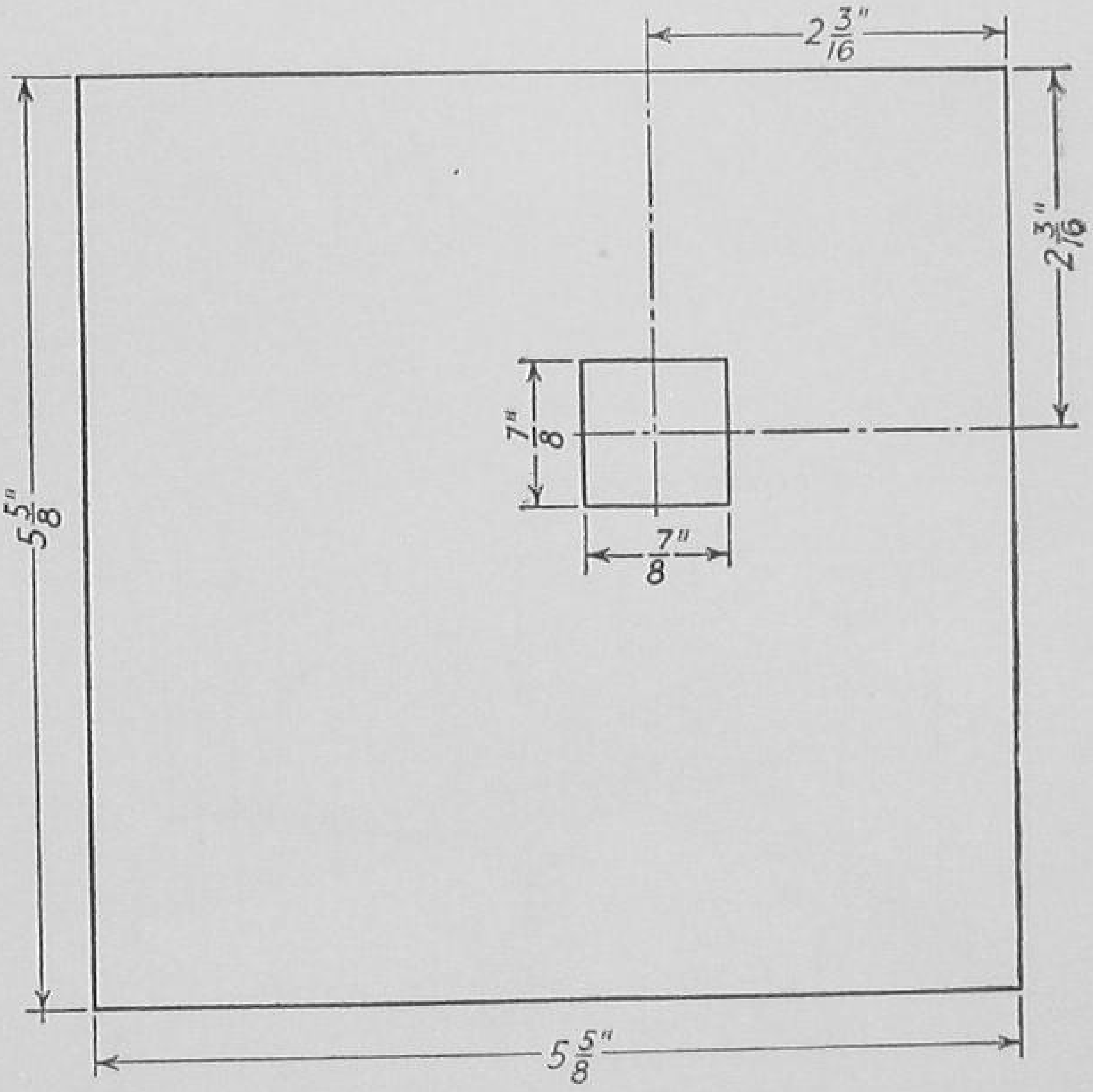


FIG. 131. Layout of base.

e. Using a backsaw, cut the cheeks of the tenon as shown in Fig. 135. Next, cut the shoulders of the tenon (Fig. 136). If the tenon has been properly layed out and cut, it should fit the mortise by pressing the two pieces together. If the fit is too tight, the cheeks of the tenon are pared lightly with a chisel until proper fit is obtained.

4. Draw diagonal lines from corner to corner on each end of the post piece to locate the center. With a 3/8″ auger bit, bore a hole through the center of this piece. It may be necessary to bore part way from each end but care must be taken to bore the holes straight so that they meet in the center of the piece.

5. On one side of the post, mark off the layout for a hole to receive the

end of the pump handle. With a 1/4″ auger bit, bore a series of holes in the rectangle as shown (Fig. 137). These holes are to reach the center of the post. Remove the balance of the wood with a chisel, cutting to the lines.

6. The same procedure is followed in making a hole to accommodate the spout on an adjacent surface. Note that this hole is made on a 10-degree slant.

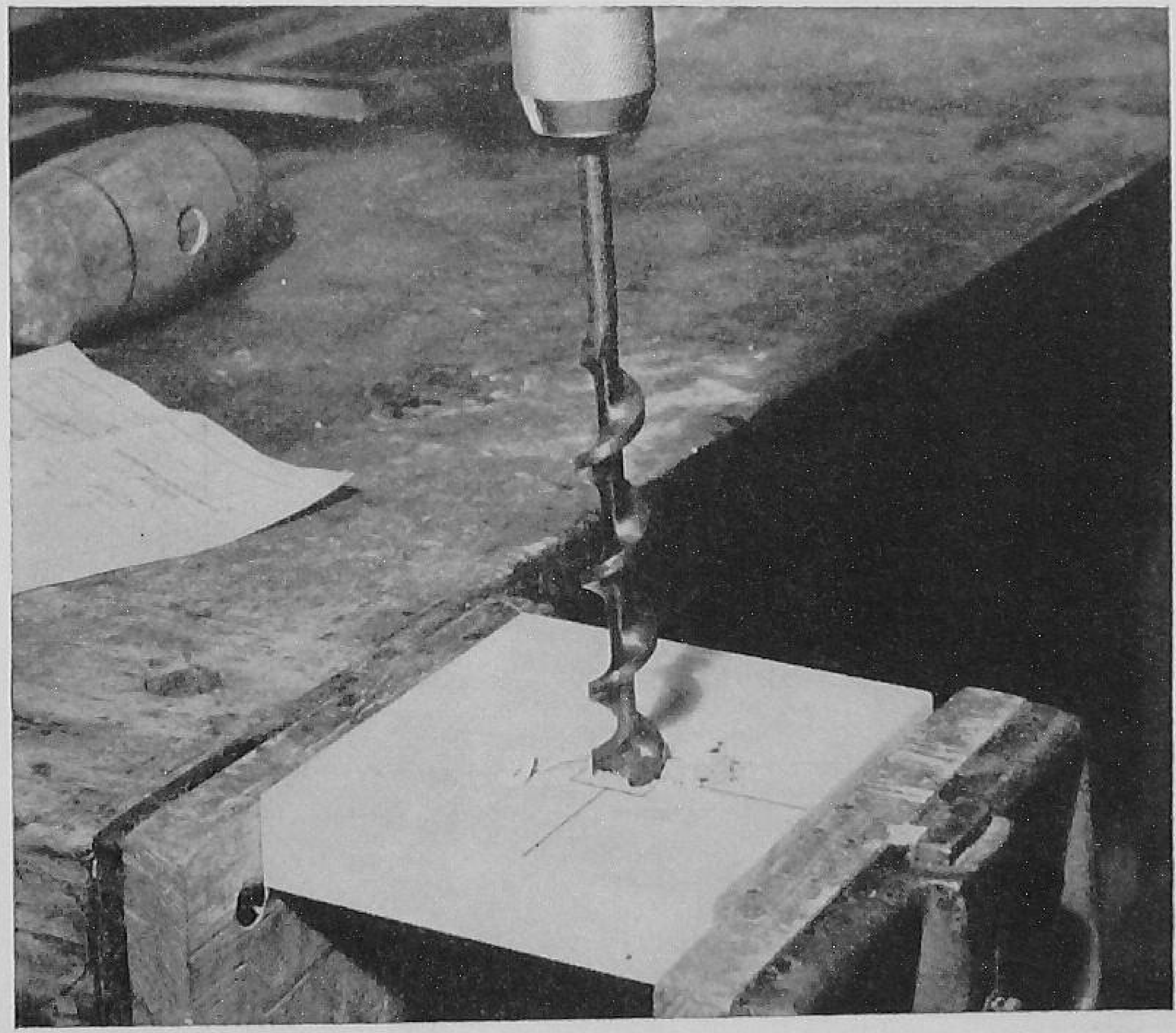


Fig. 132. Boring for the mortise.

7. Taper the corners of the post at the upper end as shown in the drawing. This can be done with a plane.

8. Cut out and shape a piece of stock for the handle.

9. Cut out and shape a piece of stock for the spout.

10. Square up and shape a piece of stock for the cap-piece that is fastened to the top of the post. In the center of this piece, bore a 3/8″ hole.

11. Cut out and square the six pieces for the planks.

12. Using ½″, No. 16 brass escutcheon pins, nail the planks to the base as shown in the drawing.

13. It may now be necessary to cut away part of the planks where they are covering the mortise hole in the base.

14. Sand all parts with 2/0 sandpaper.

15. Put some glue on the tenon and press the post into the base, making sure that there is a tight fit on all sides.

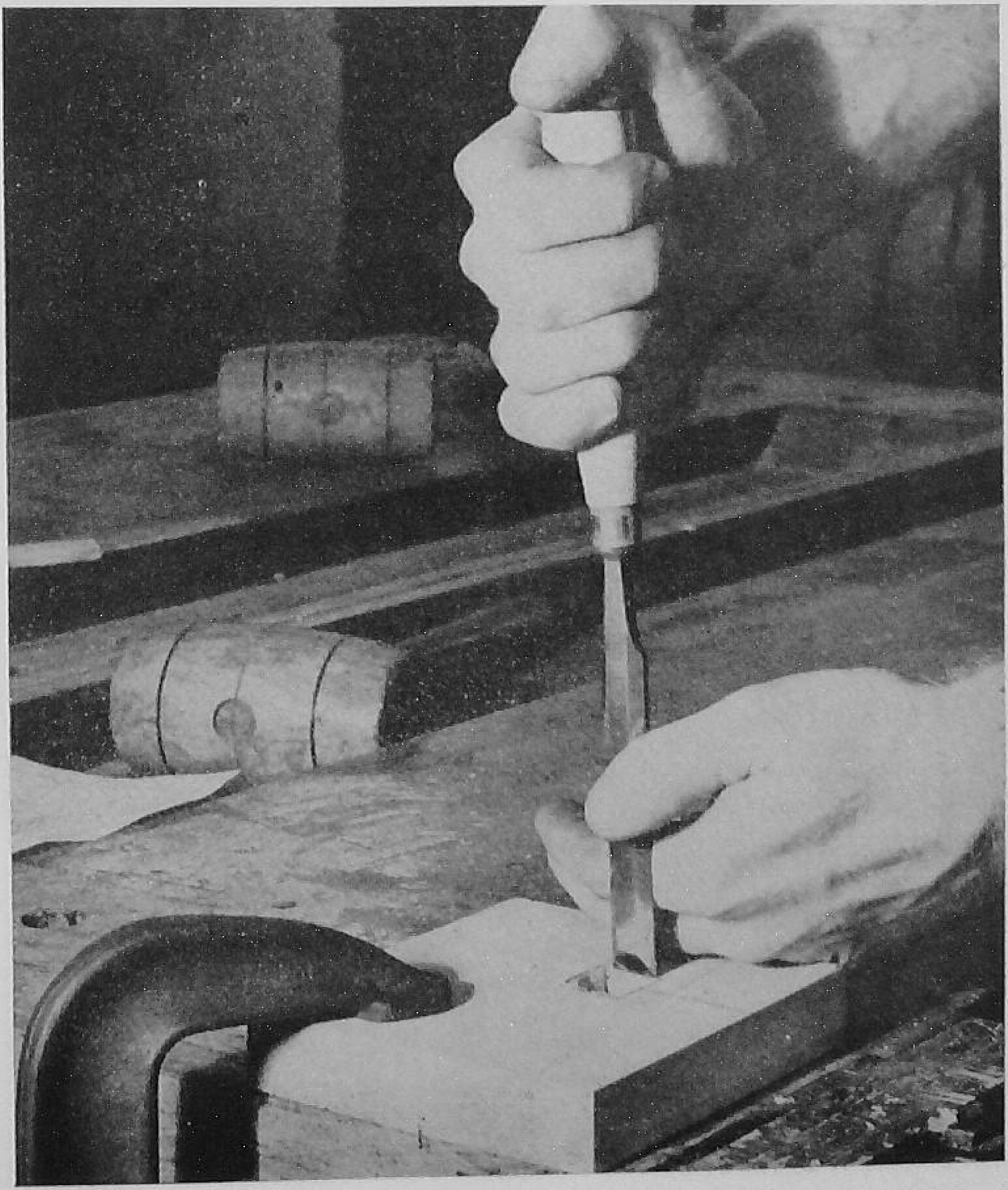


Fig. 133. Chiseling out the mortise.

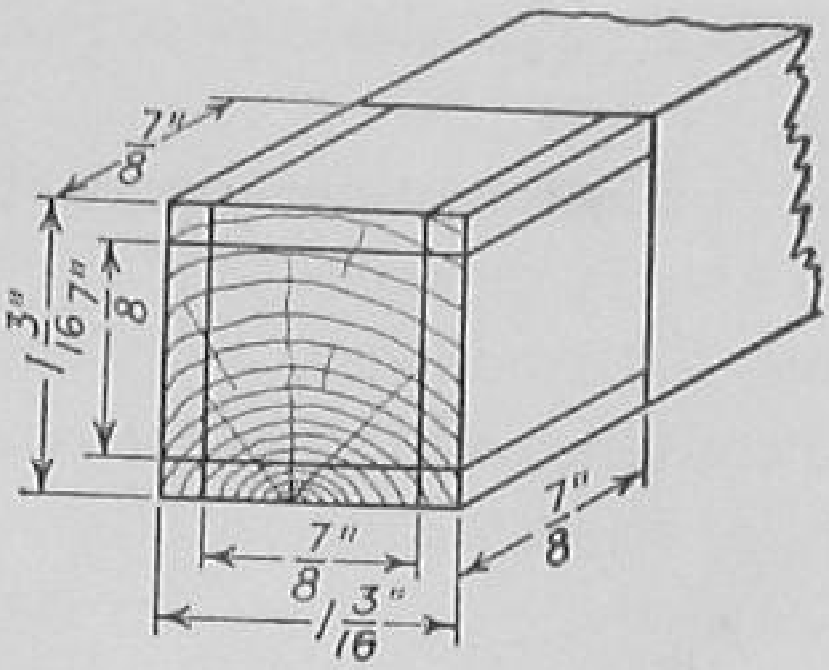


FIG. 134. Layout of tenon.

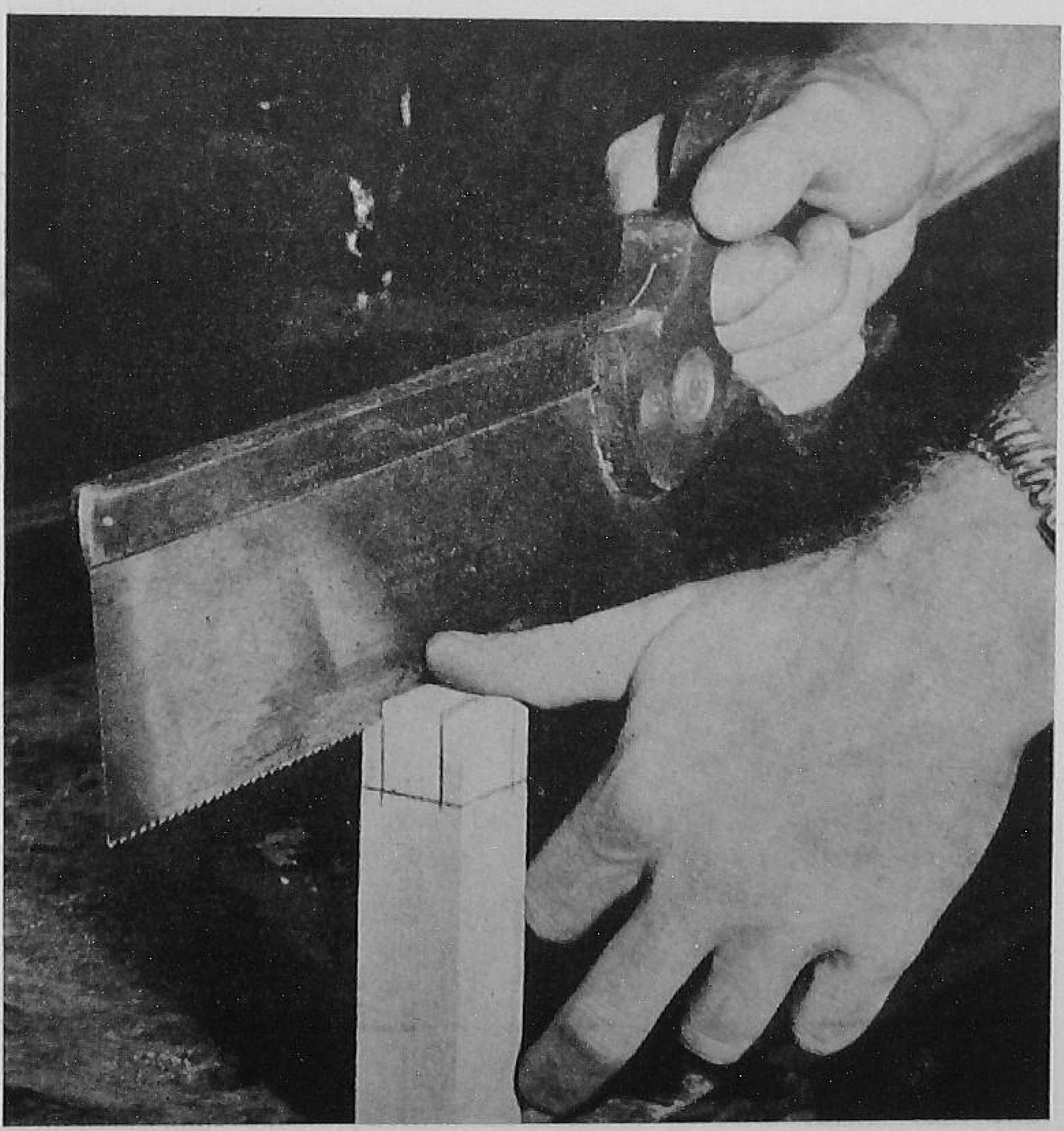


FIG. 135. Cutting the cheeks of the tenon.

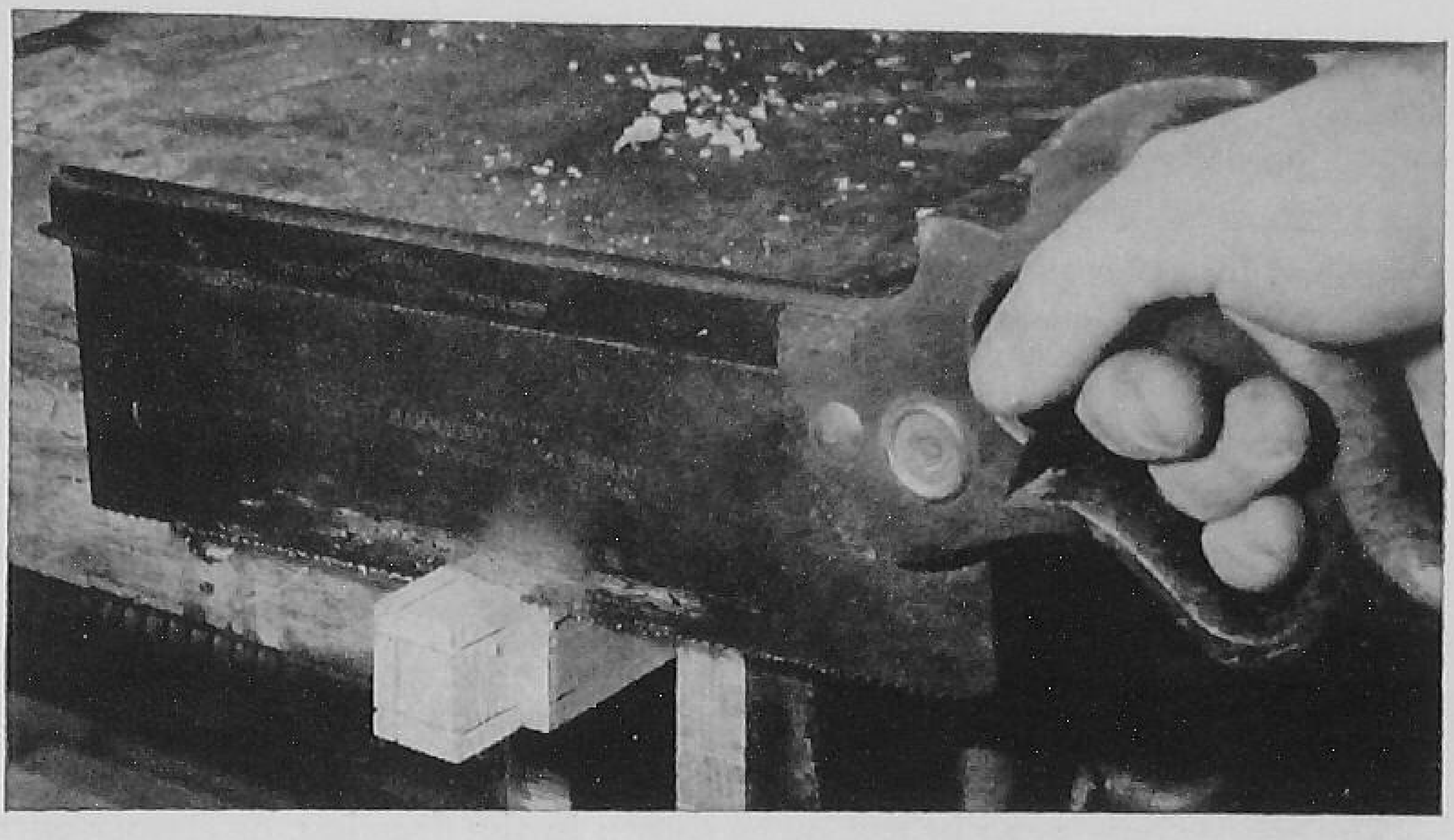


FIG. 136. Cutting the shoulders of the tenon.

16. With a 3/8″ auger bit, bore a hole into the edge of the base until it meets the hole in the center of the tenon on the post. This hole is for the wire.

17. Using 1/2″, No. 16 brass escutcheon pins, fasten the cap piece on the top of the post.

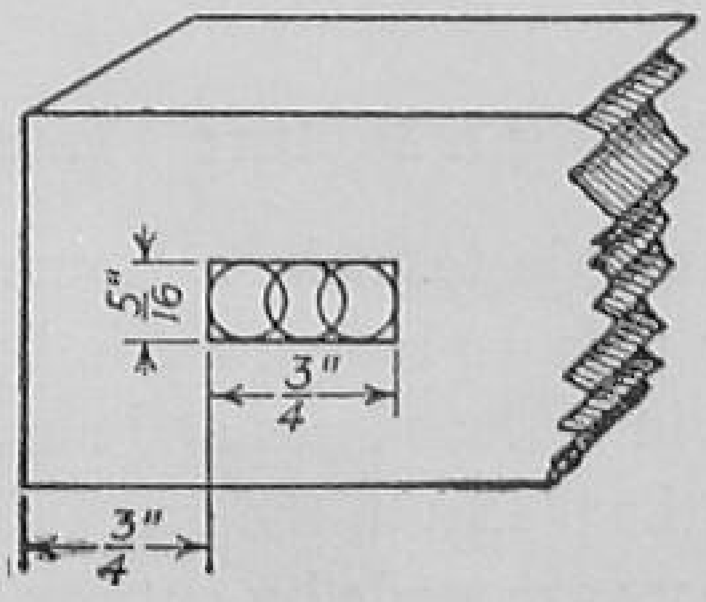


FIG. 137. Boring post for handle.

18. Glue the spout in place.

19. In the end of the handle that pivots in the slot cut in the post, drill a small hole as shown in the drawing. On the other end of the handle, drill a 1/8″ hole to accommodate the pull chain of the socket as shown in the picture.

20. Fasten the handle in the post with a 1 1/8″, No. 14 finishing nail. Set

the head of the nail with a nail set and try the handle to see that it works freely.

21. Sand the entire job with 4/0 sandpaper.

22. Stain with walnut oil stain and apply a shellac and wax finish as described for other projects.

23. Obtain a piece of ⅛″ threaded pipe, 2″ long and screw this into the hole at the top of the lamp. Turn it down until about ⅜″ is left above the top of the lamp. This will be enough for fastening the socket.

24. A simulated bucket can be made by obtaining a piece of wood 2″ thick, 2″ wide and 2″ long. Locate the center of each end by drawing diagonals from corner to corner. With a compass, or dividers, scribe a 2″ circle on each end. With a 1¾″ forstner bit, bore a hole almost to the bottom of the piece. With a plane, round off the corners to the circle lines and sand smooth.

The copper bands can be put on as shown in the drawing, or copper wire may be used as shown in the picture. If the handicraft worker has a wood turning lathe available, the bucket may be turned on the lathe and finished to the dimensions shown in the drawing.

25. Apply the same finish to the bucket as was applied on the lamp and fasten the bucket to the base with a small wood screw.

26. Obtain a pull chain socket, a plug, and 8′ of silk covered lamp cord and proceed to wire the lamp.

Making a Picture Frame

In many cases it is desirable to make a frame for decorating a picture made by inlaying, or for a wall placque made by carving. Picture frame molding can be obtained in various sizes and shapes to suit the individual but it is necessary to cut the pieces to the exact size to fit the picture being framed. The square corners are made by cutting a miter which is an angle of 45 degrees. When the two adjacent miters are fitted they form an angle of 90 degrees.

1. The piece of molding is placed in a miter box in which the angle of the saw has been adjusted to 45 degrees, and the piece is cut on one end (Fig. 138). The desired length is marked off and the other end is cut.

The miter box is an apparatus in which a piece of wood can be held or clamped while a guided saw makes a cut. The guides which hold the saw can be set so that the cut is made at exactly 90 degrees or at any smaller angle down to 30 degrees, or in some cases less. The saw has a heavy back

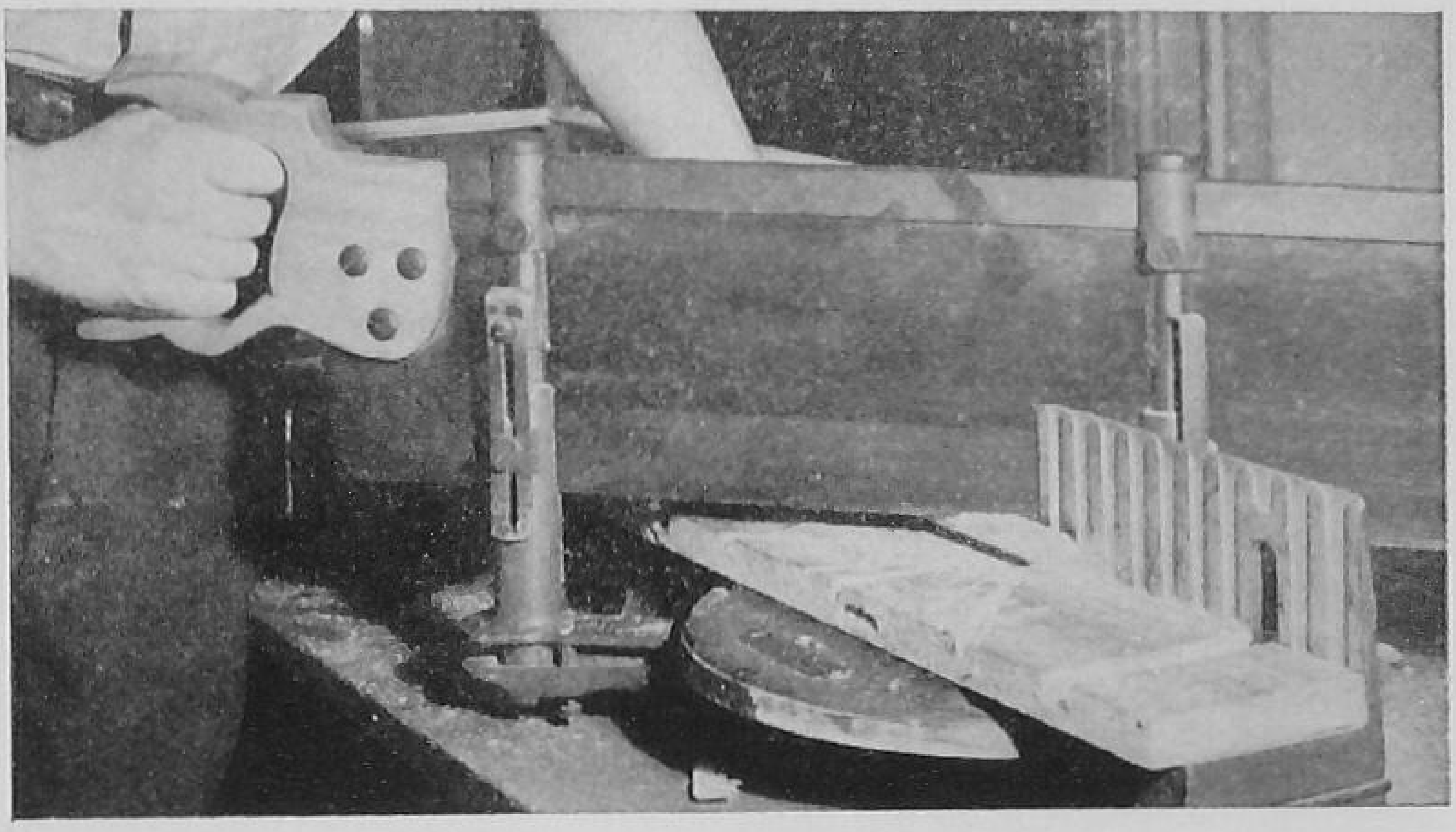


FIG. 138. Cutting a miter in miter box.

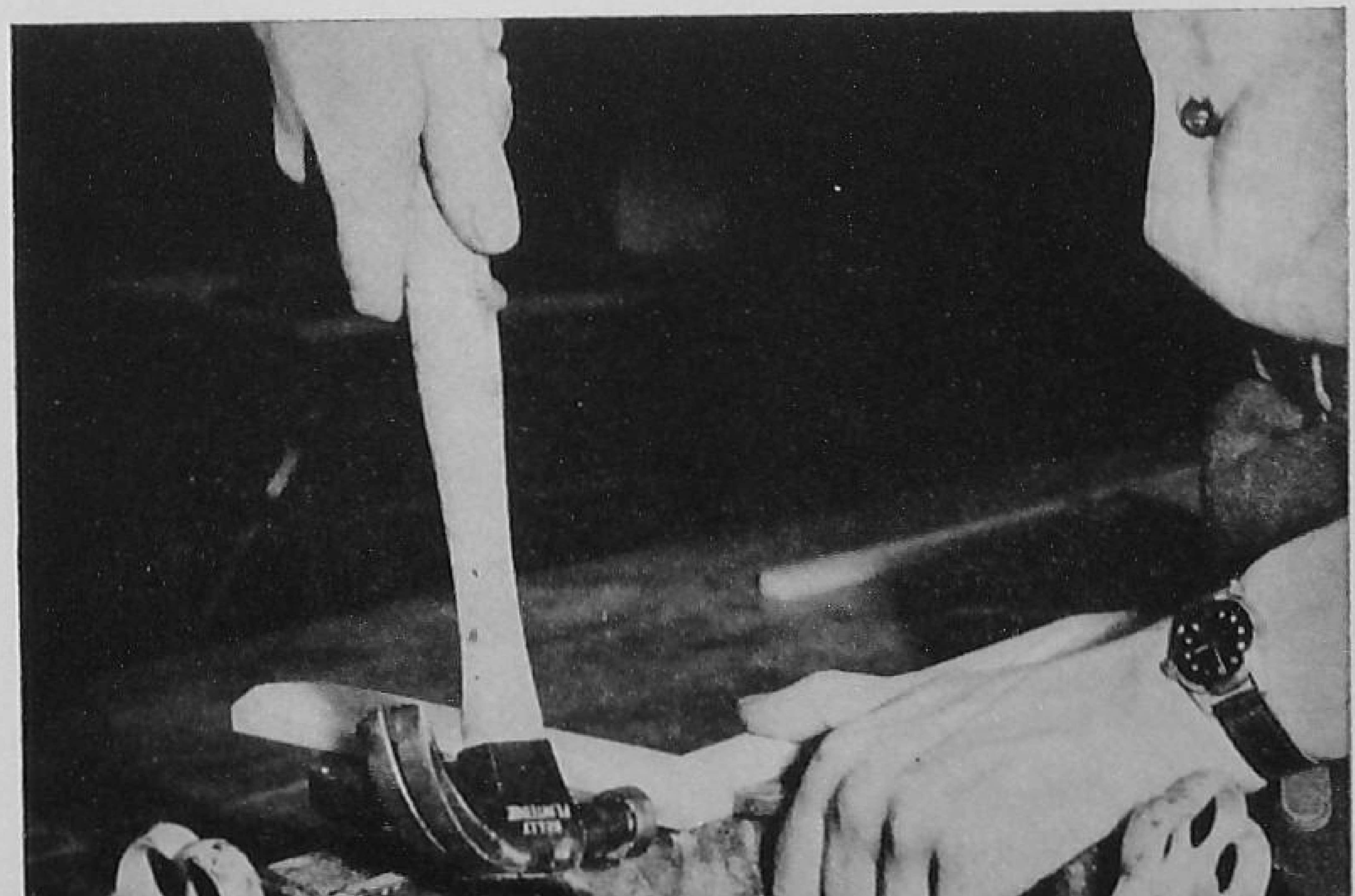


FIG. 139. Assembling a miter joint using miter vise.

or rib which fits the guides. It is often provided with clamps to hold the work in place while a cut is being made; catches to hold the saw above the work except when it is actually being used; special marks to facilitate cutting special shapes; demountable parts so that the tool can be carried

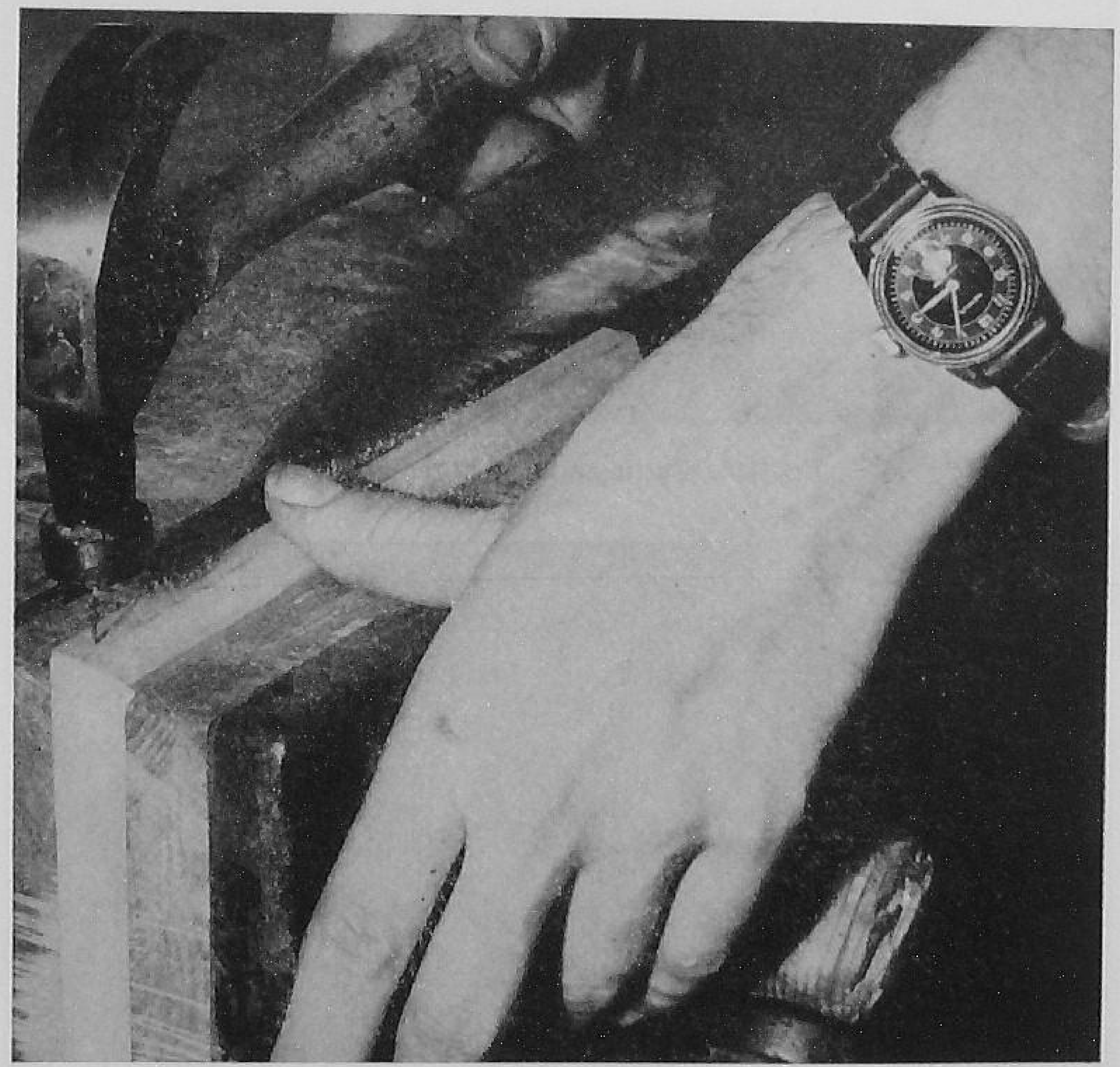


FIG. 140. Assembling a miter joint in bench vise.

about easily. The miter box is used to make accurate miter cuts for joints in frames, boxes, and construction work.

2. Glue is applied to the joint and if a miter vise is available the pieces are clamped for nailing (Fig. 139). If a vise is not available, the frame can be clamped in a bench vise and nailed as shown in Fig. 140.

3. After fastening the frame, it is sanded and finished as described for preceding projects.

Some workers will prefer to make their own picture frames and decorate them by carving a design on the frame.

Additional Suggested Projects

1. Letter Holder (Fig. 141).
2. Book Ends (Fig. 142).
3. Scotty Book Ends (Fig. 143).
4. Kitchen Shelf (Fig. 144).
5. Old Town Pump Desk Lamp (Fig. 145).
6. Foot Stool (Fig. 146).
7. Cigarette Box (Figs. 147 and 148).

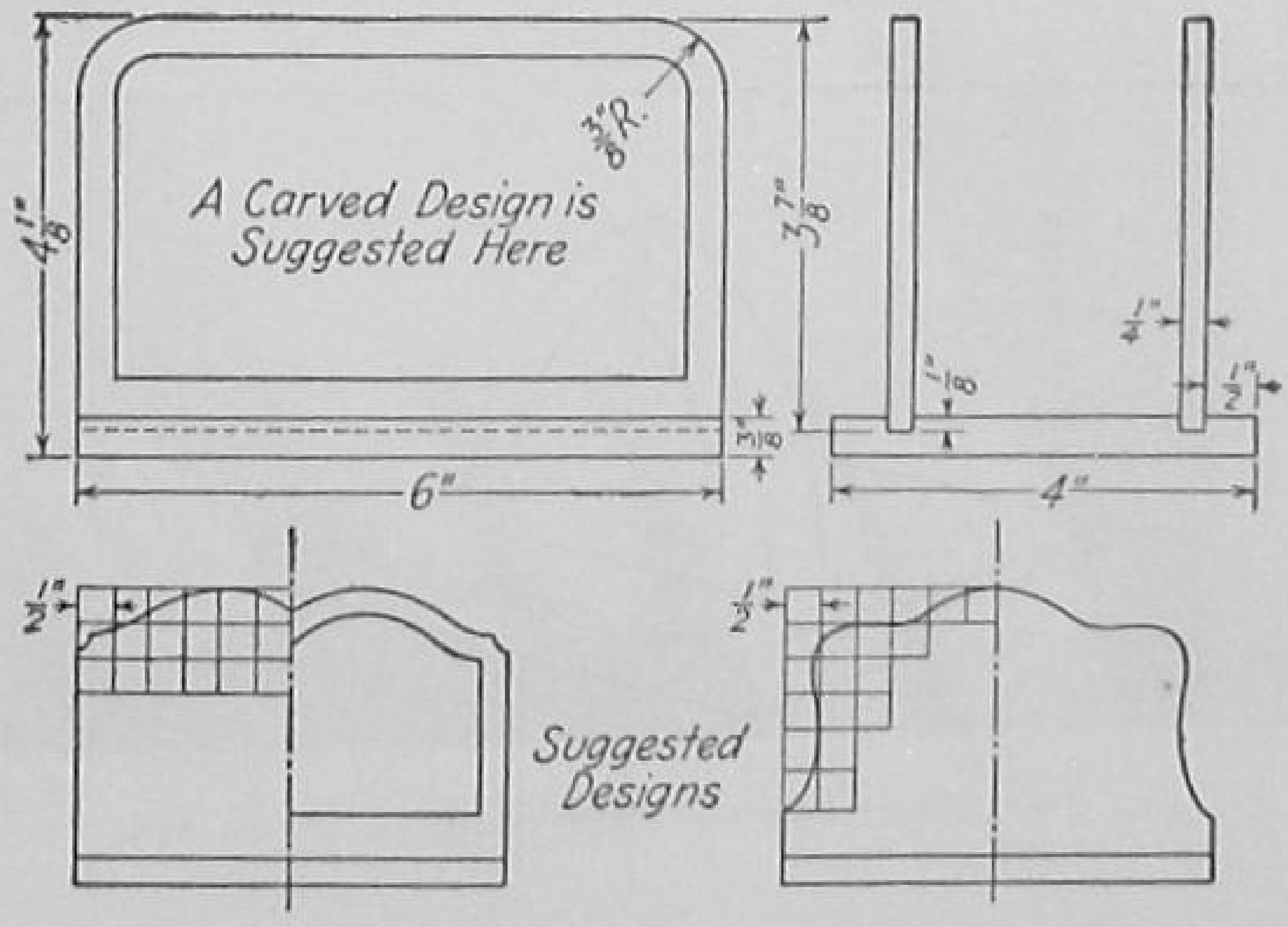


Fig. 141. Letter holder.

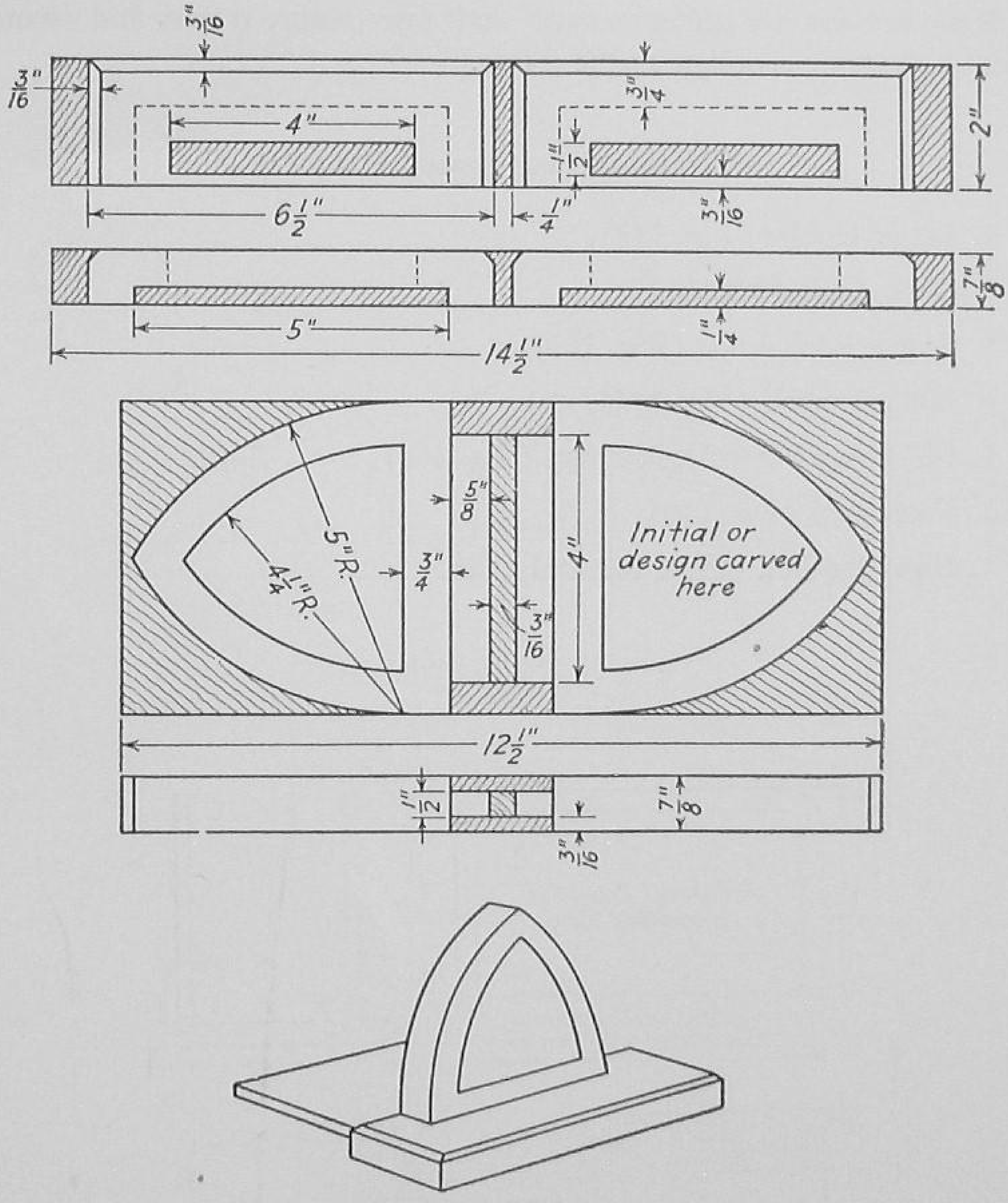


FIG. 142. Book ends.

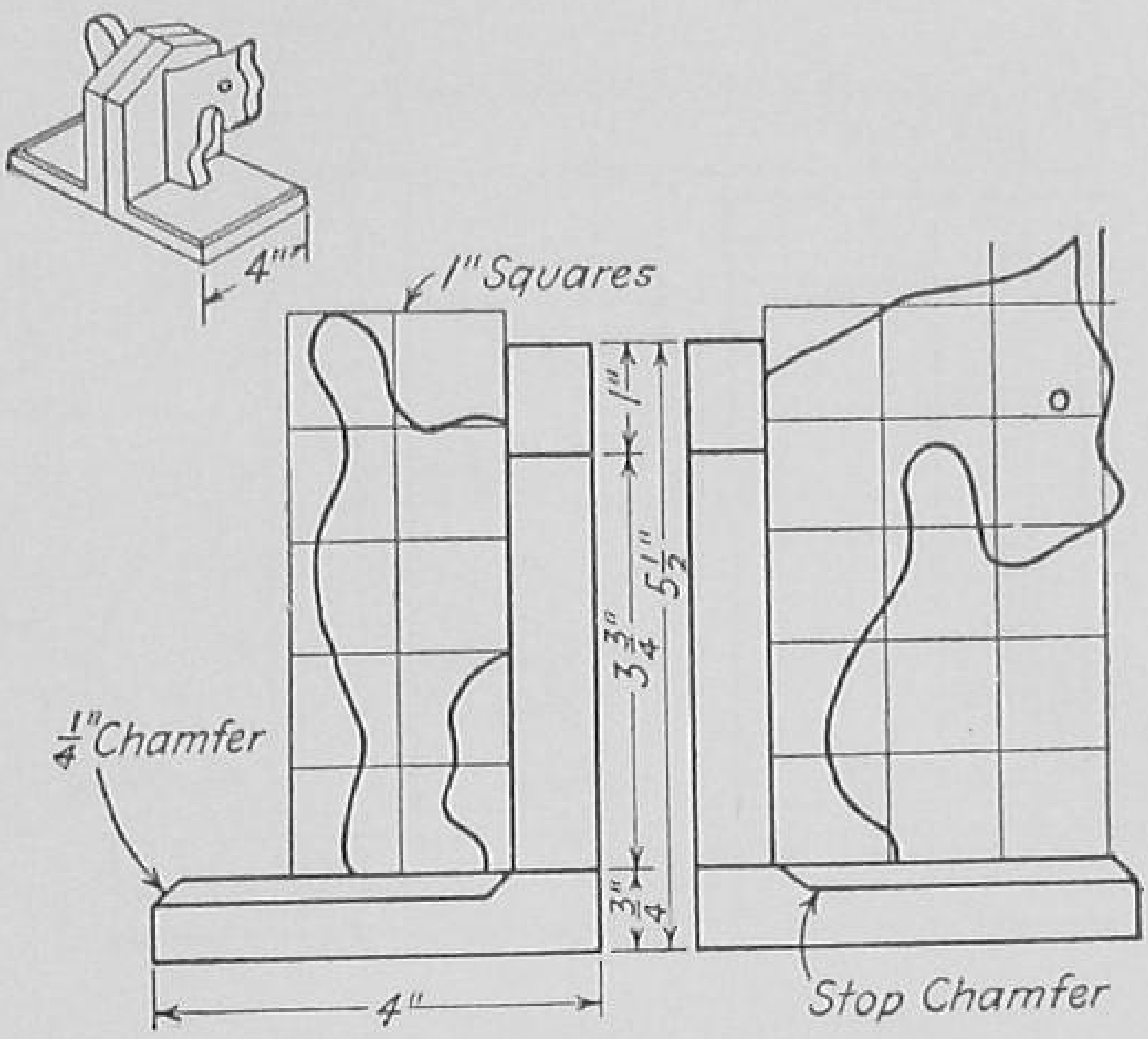


FIG. 143. Scotty book ends.

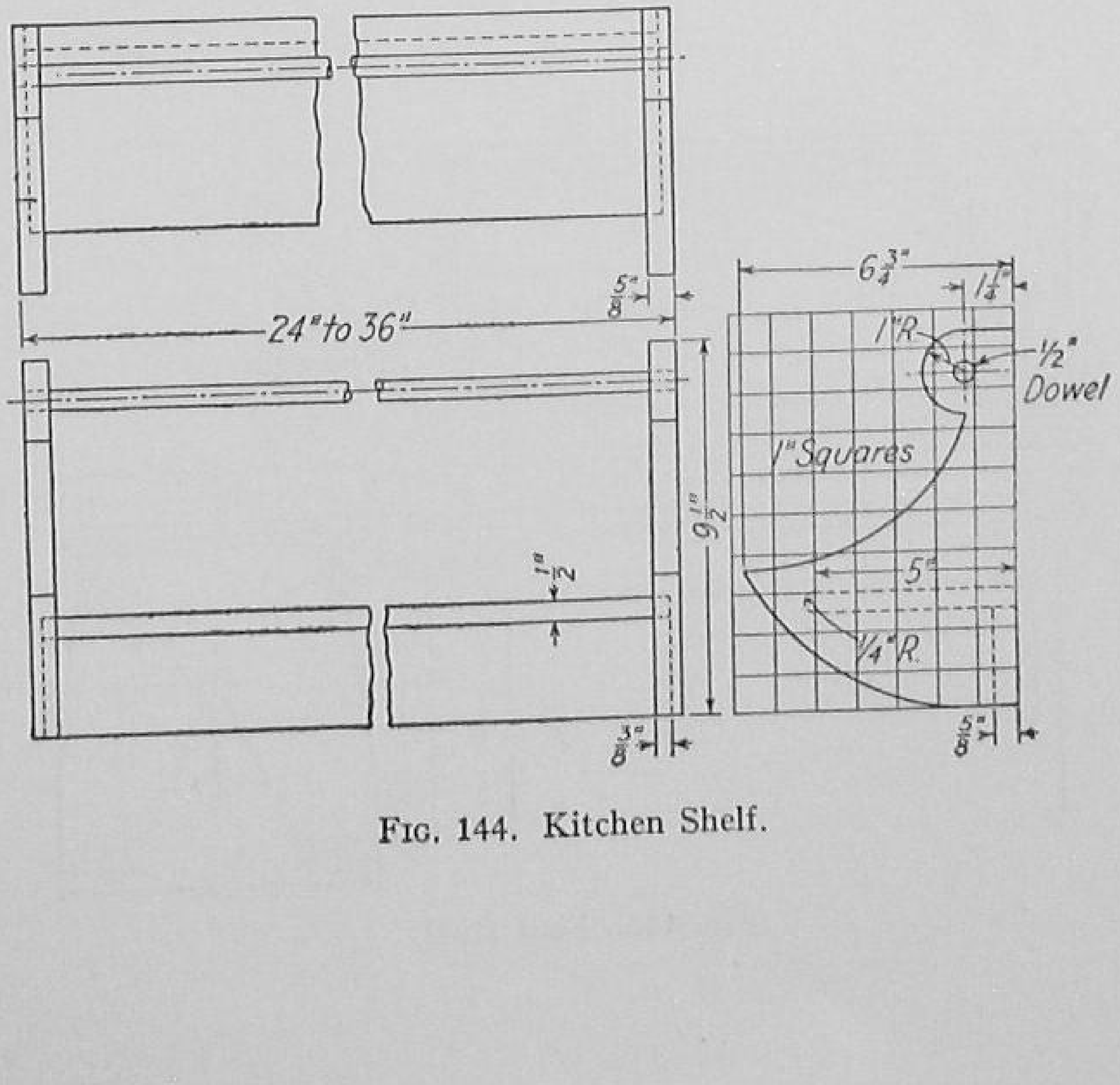
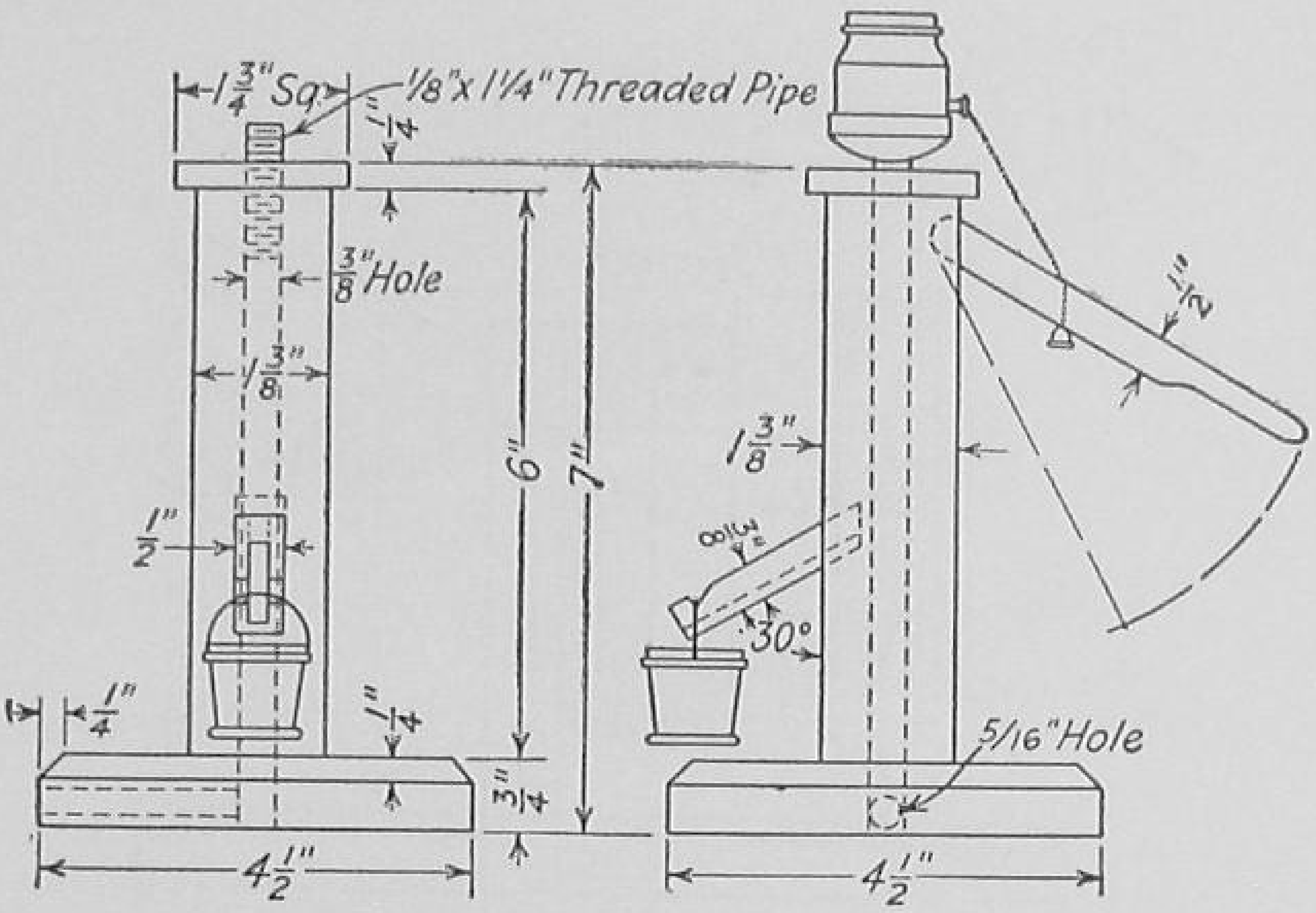


FIG. 144. Kitchen Shelf.



MATERIAL	REQUIRED	
Base	1 Pc.	3/4" x 4 1/2" x 4 1/2"
Upright	1 Pc.	1 3/8" x 1 3/8" x 6"
Cap	1 Pc.	1/4" x 1 3/4" x 1 3/4"
Spout	1 Pc.	3/8" x 1/2" x 2"
Bucket	1 Pc.	1" x 1" x 1 1/4"
Handle	1 Pc.	3/8" x 1/2" x 5"

FIG. 145. Pump lamp.

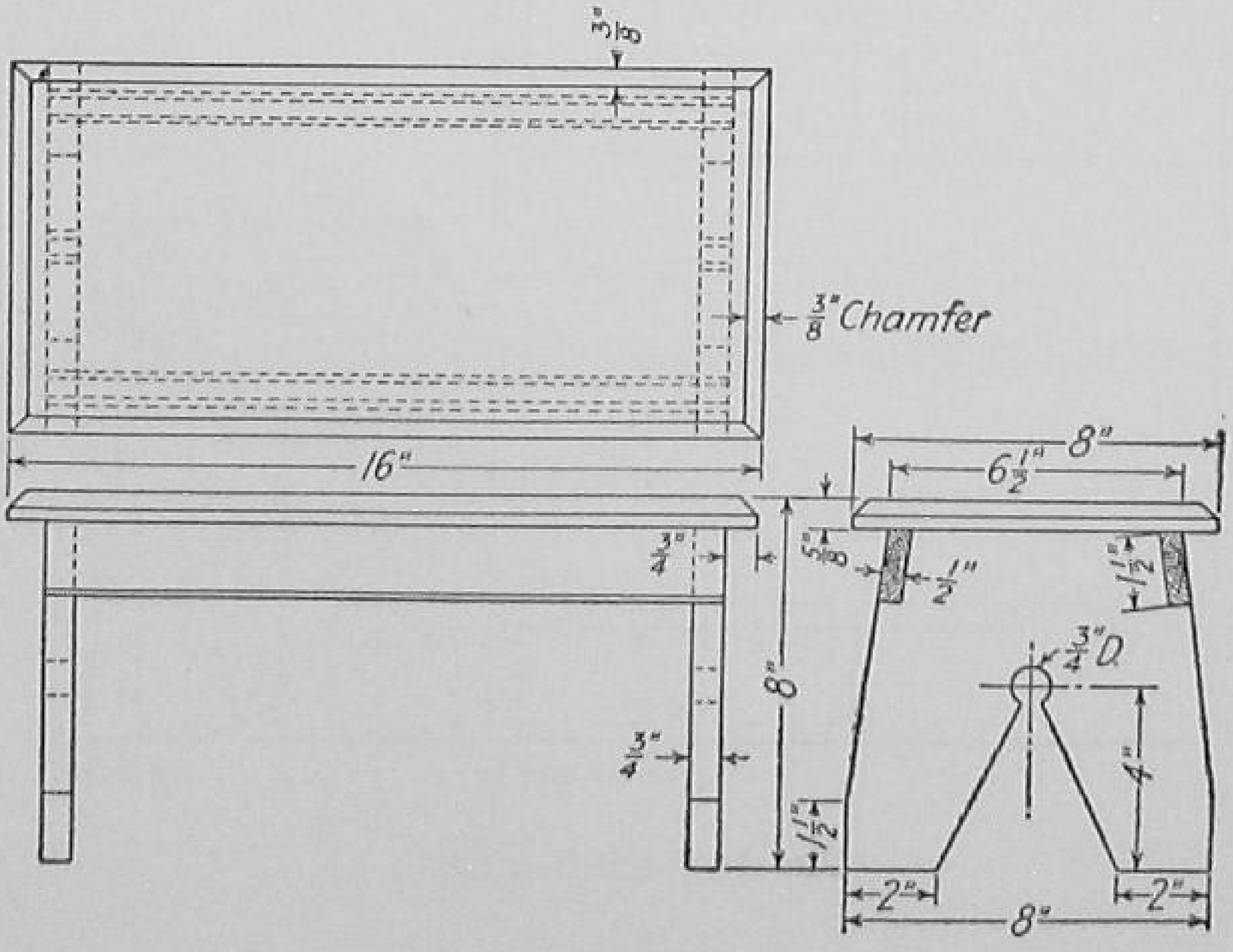


FIG. 146. Foot stool.

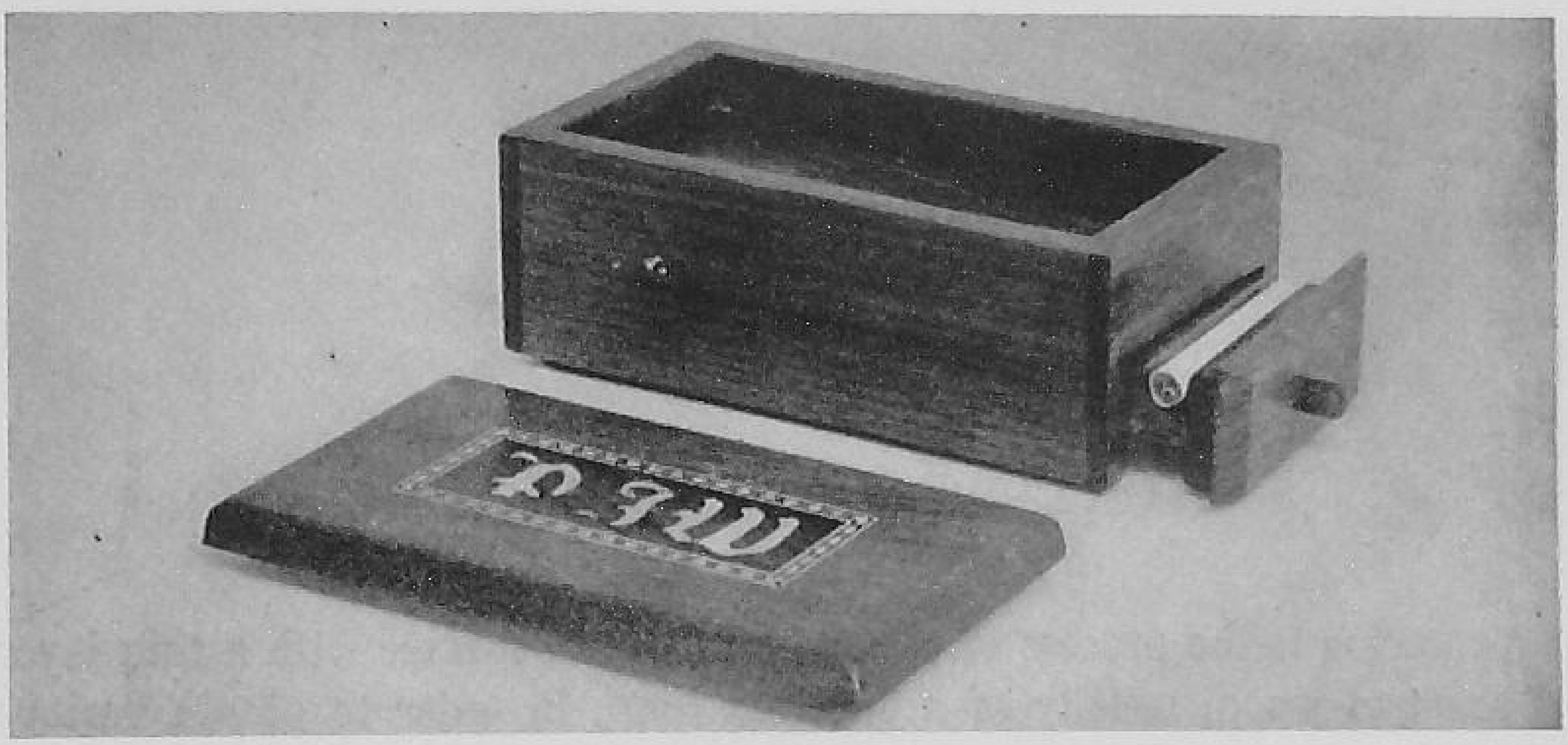


FIG. 147. Cigarette box.

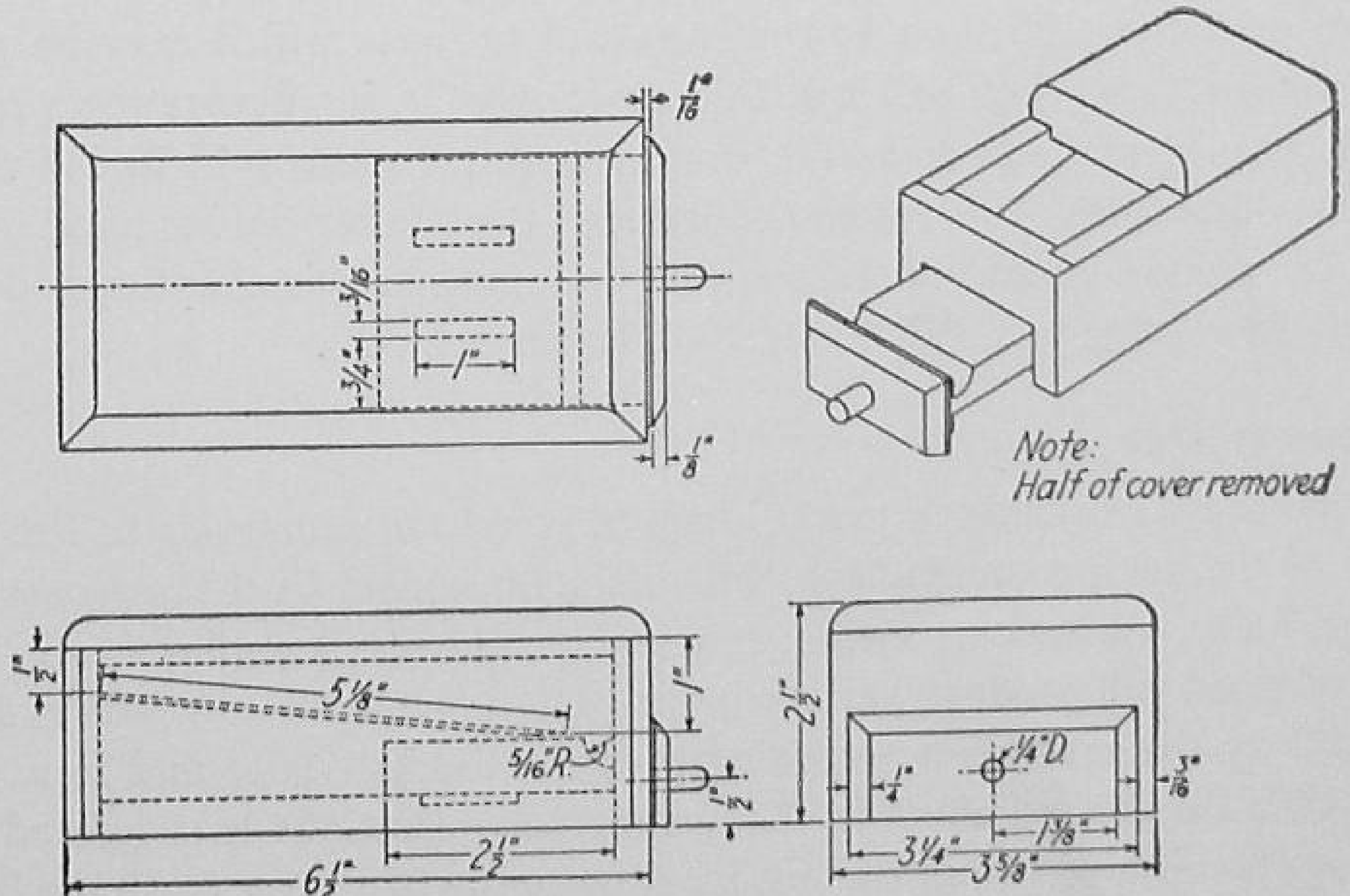


FIG. 148. Drawing of cigarette box.

Chapter IV

INLAYING AND VENEERING

Veneering is the process of covering a wooden surface with a thin layer or sheet of wood, usually of a different kind, in order to obtain various effects by taking advantage of different grain patterns and different colors of wood. Inlaying, or marquetry, is the placing of a thin sheet of wood in the surface of another piece of wood in order to obtain different effects through the use of varying colored woods.

This craft is easy to learn and is extremely interesting to the handicrafter as there is no limit to the beautiful projects which may be made. The woodcraft worker will use this craft mostly for decorating projects which may be made later as the worker acquires more skill in the use of woodworking tools. It is recommended that the worker try his hand at this craft by making several of the projects described in this chapter, and later use his knowledge and skill to decorate larger projects.

Woods to Use

Veneers are available in many kinds of wood too numerous to list here. Some of the more common types which should appeal to the beginner are: ebony, holly, mahogany, maple, rosewood, satinwood, and walnut. Each type of wood will produce various grain patterns and colors which must be selected by the craftsman according to his individual taste and in accordance with the desired effect in the completed project. It is suggested that catalogs be obtained from various manufacturers of veneers which will list and describe each type of veneer being manufactured.

The various veneers are manufactured in sheets, usually 6″ to 12″ wide and 36″ long. The thickness is usually 1/28″. The sheets are sold by the square foot and should be ordered in that manner.

Many veneer manufacturers package various assortments of veneers making up combinations of from three to twelve different kinds of wood. The packages usually contain from 12 to 35 square feet of veneer. It is

suggested that the woodcraft worker select one of these packages from the manufacturer's catalog for use in the first few projects.

Inlay borders may be purchased in a great variety of color and pattern combinations. Such borders are sold in 3′ lengths ranging in price from approximately five cents to seventy-five cents per length. They are $\frac{1}{28}$″ thick and vary in widths from $\frac{1}{16}$″ to $\frac{1}{2}$″.

Making a Veneer Picture

In developing an inlay picture, the major problem is to make the various parts of the picture (the different types of wood used) fit into each other as closely as possible, similar to the parts of a jigsaw puzzle. It is recommended that a simple silhouette design, such as that shown in Fig. 149, be

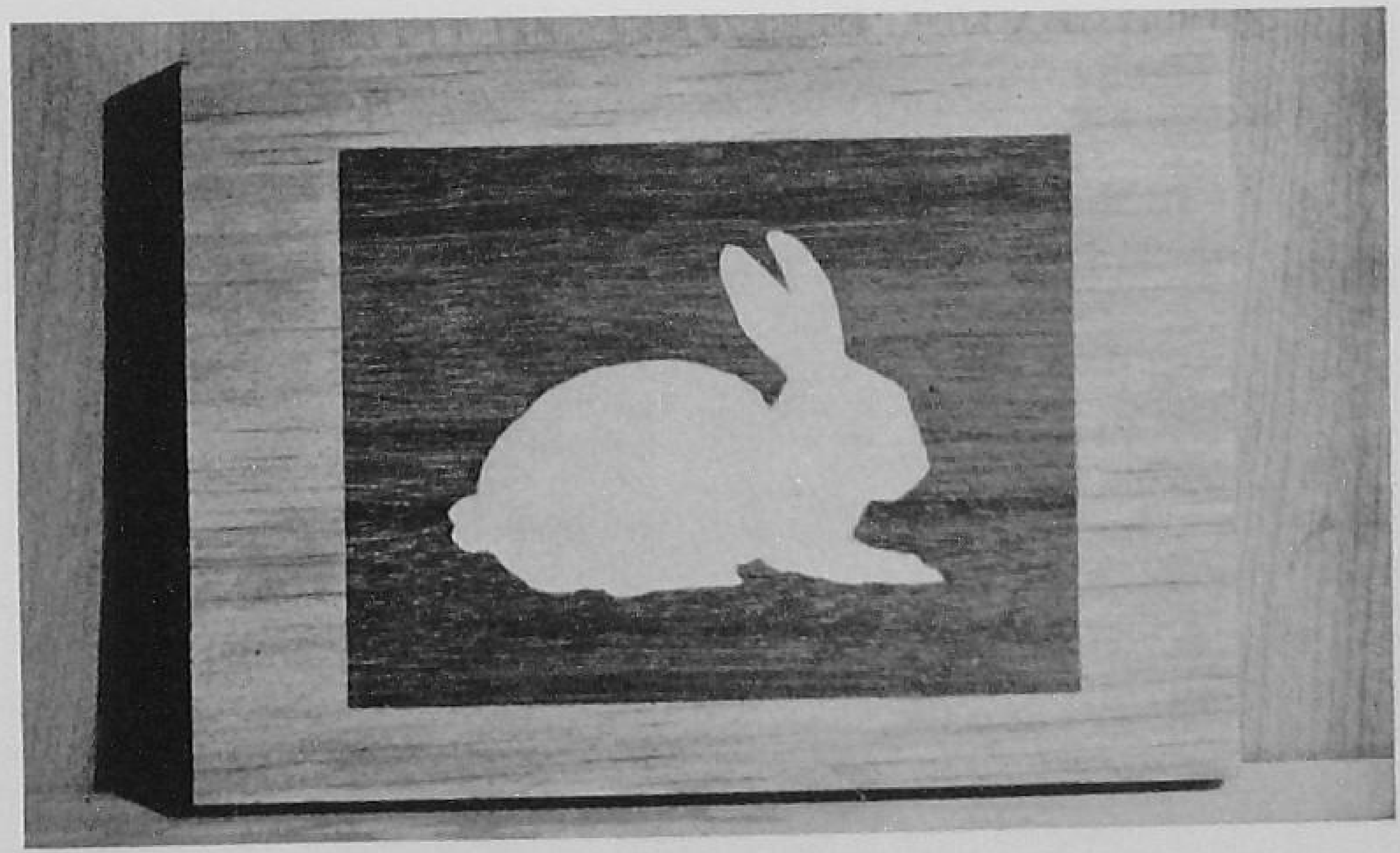


FIG. 149. An inlayed picture of simple design.

used for the first attempt at inlaying. In order to make the figure stand out, two contrasting woods should be used, such as holly and walnut, or holly and mahogany. This will produce the figure of the rabbit as white and the background as dark. The over-all dimensions of the picture are 3″ x 5″.

Procedure.

1. Lay a piece of plywood or other suitable material on the work bench to use as a flat surface for cutting the veneer. A veneer saw knife shown in Fig. 150 should be used for cutting the veneer. This produces a clean and straight edge on the veneer. From a sheet of light and one of dark veneer cut a piece approximately 4″ x 6″. The veneer is laid flat on the cutting board and a straightedge such as the blade of a try square is held tightly on the top of the veneer. Place the blade of the veneer saw knife against the straight edge and draw the saw toward you while pressing down firmly enough to cut through the veneer (see Fig. 151).

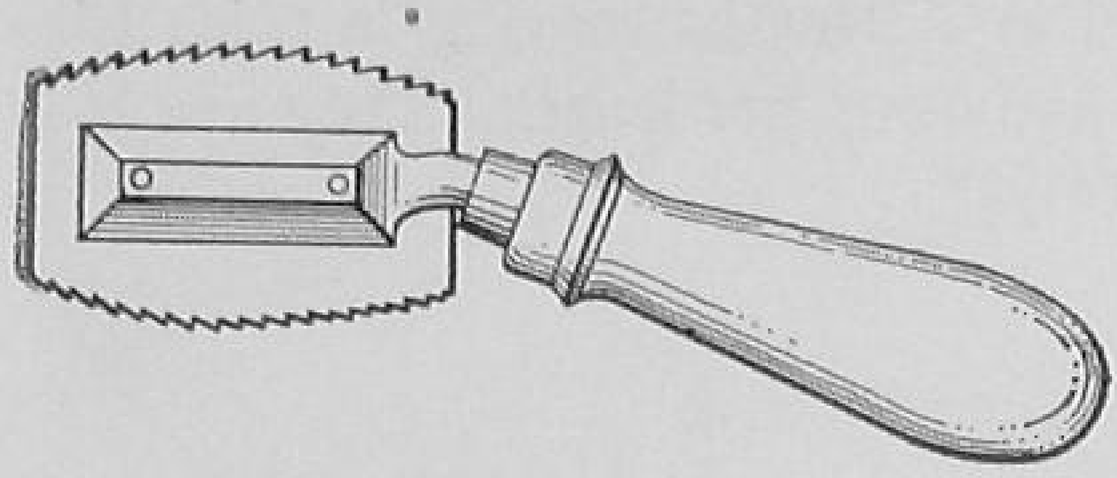


FIG. 150. Veneer saw knife.

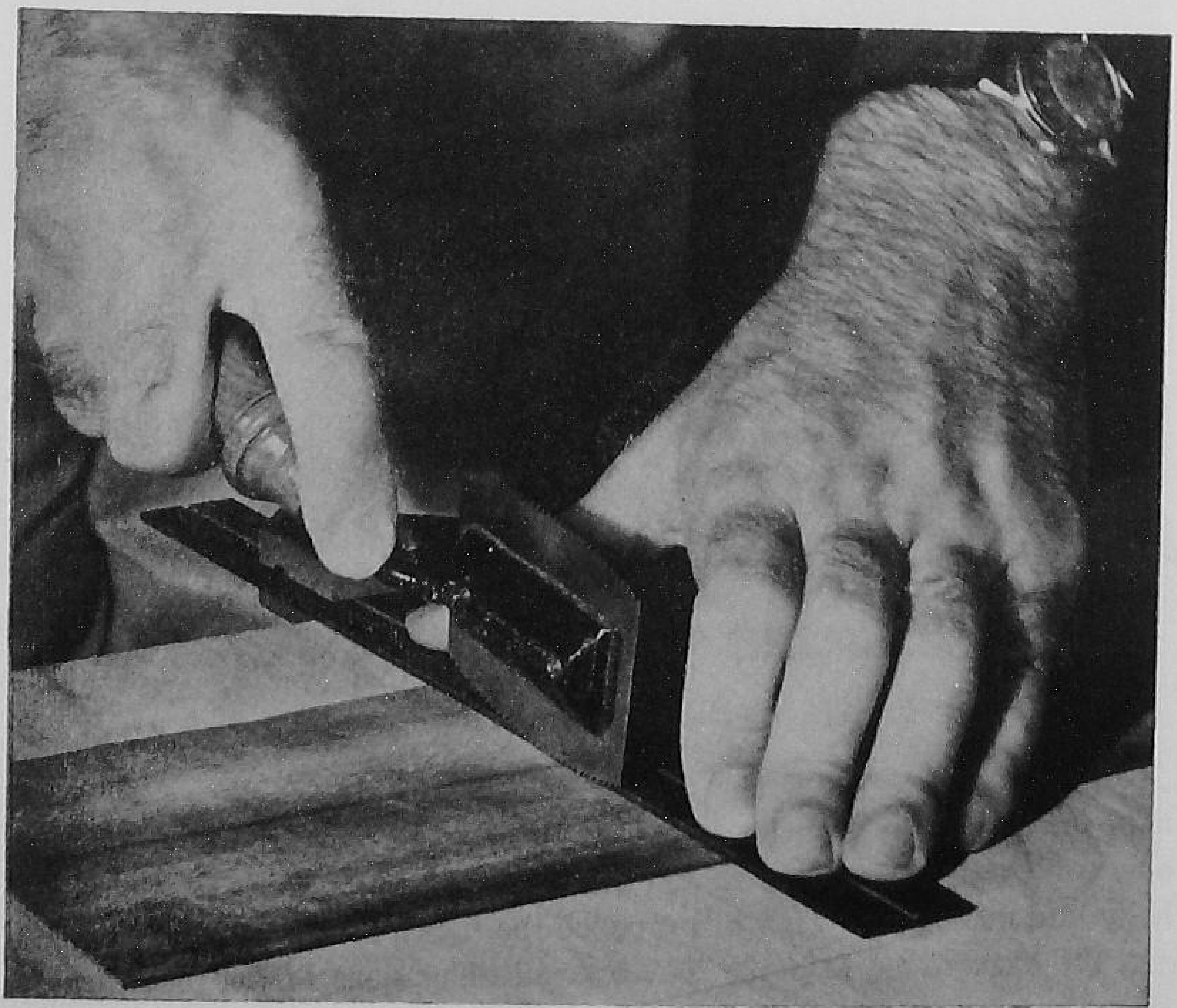


FIG. 151. Cutting with veneer saw knife.

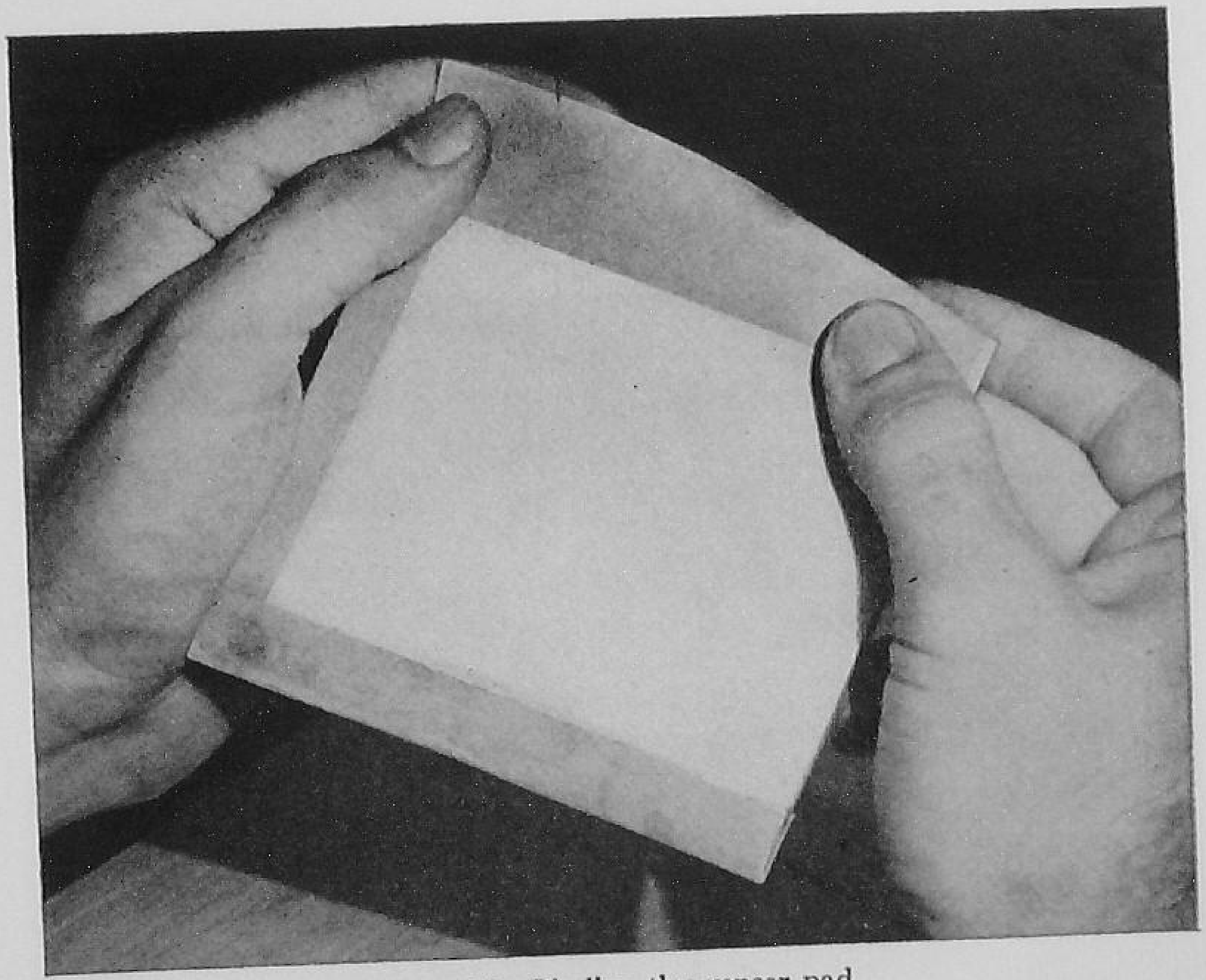


FIG. 152. Binding the veneer pad.

2. Place the two pieces, one on top of the other, and bind them tightly together along the edges with gummed paper tape as shown in Fig. 152.

3. The design (Fig. 153) is now transferred to the built-up pad of

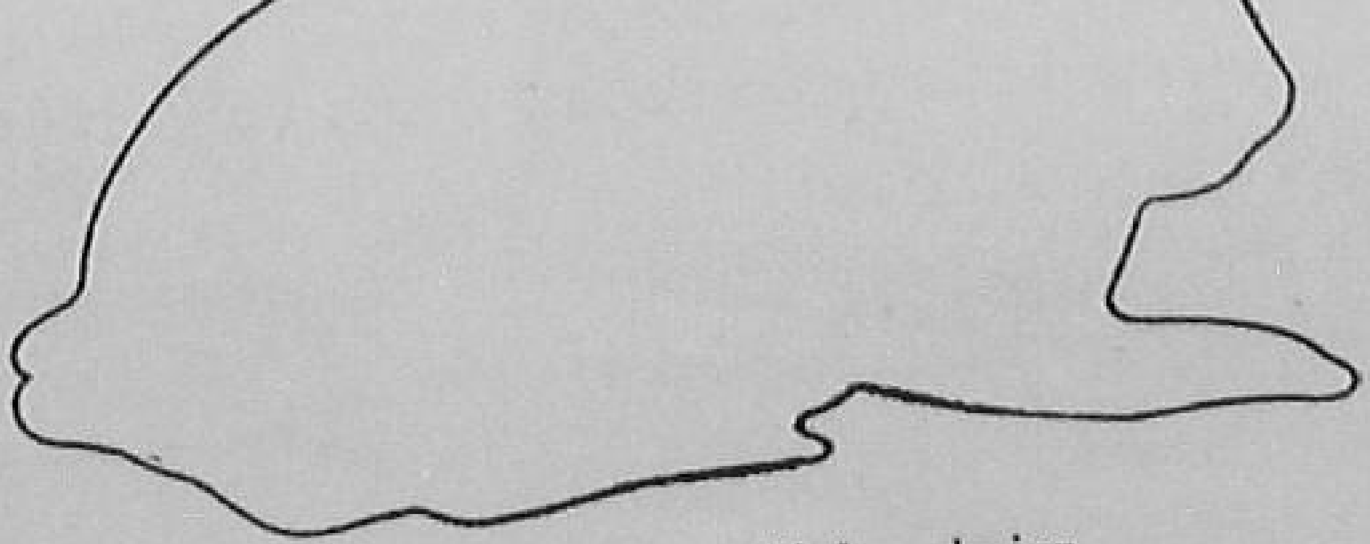


FIG. 153. Pattern of inlay design.

veneers. Trace the design on tracing paper, then using a piece of carbon paper between the tracing paper and the veneer pad, transfer the design in the center of the lighter colored wood, using a sharp-pointed pencil. The tracing and carbon papers may be held in place by paper clips as shown in Fig. 154. When the tracing and carbon paper are removed, the design

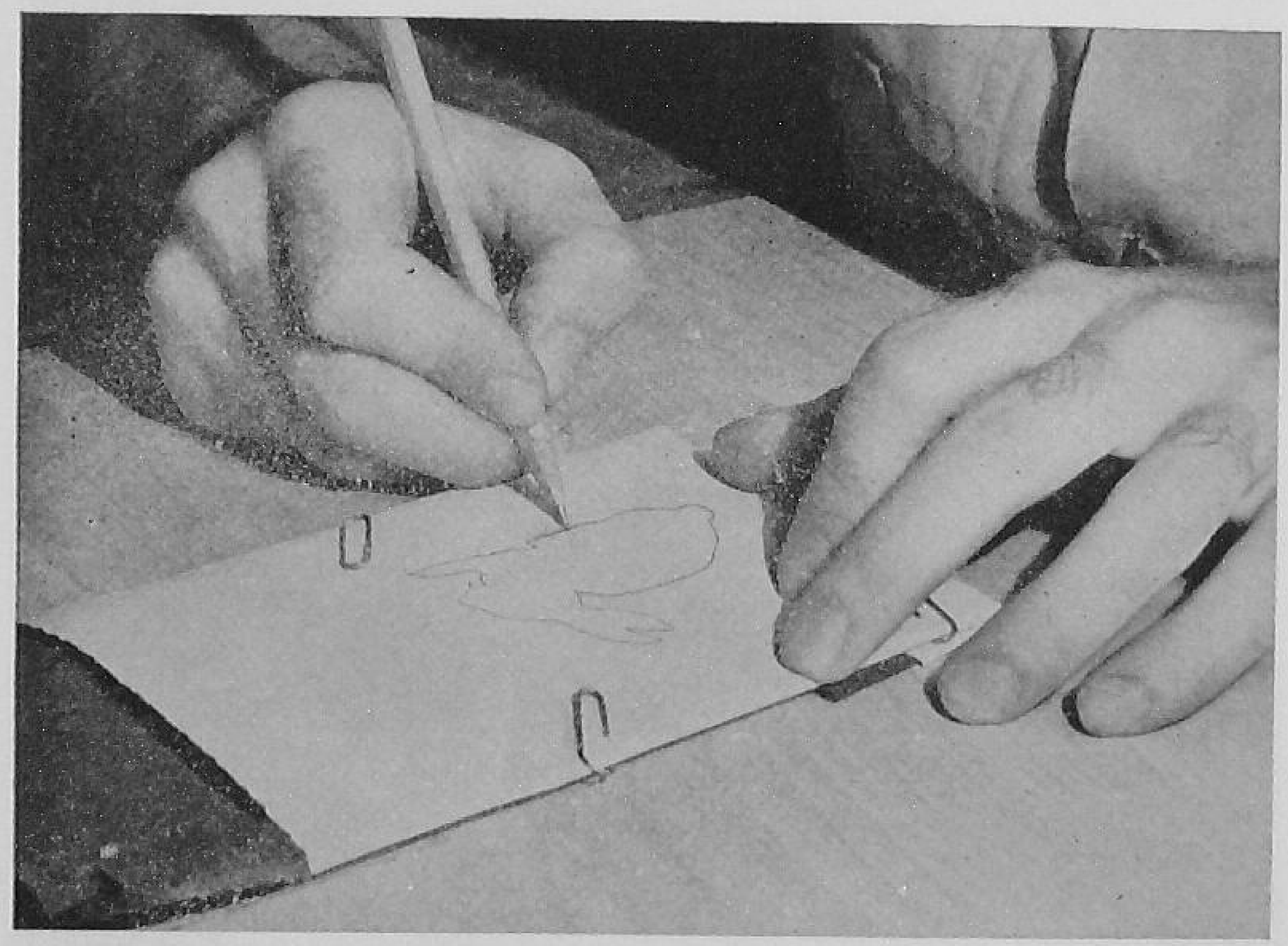


Fig. 154. Transferring the design to the pad.

should show clearly on the face of the veneer. Another suitable method of transferring the design is to cement the tracing paper directly on the wood, using rubber cement. The sawing is then done through the paper.

4. The next operation is to saw out the design in order to remove the rabbit from the center of the pad. The sawing is done with a jeweler's saw (Fig. 155) which is held in a jeweler's saw frame (Fig. 156). These saws

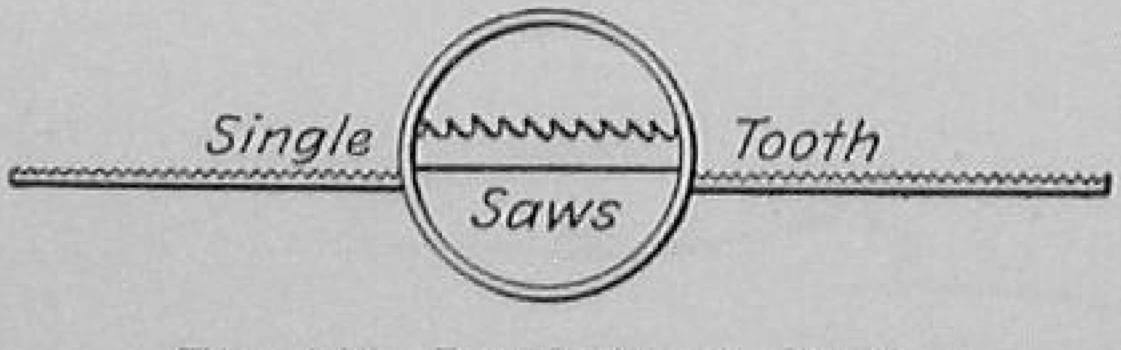


Fig. 155. Jeweler's saw blade.

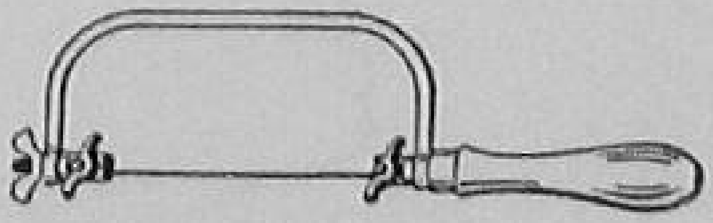


Fig. 156. Jeweler's Saw.

are manufactured in various thicknesses, widths, and number of teeth, but are designated by numbers ranging from 000000 to 15, depending on the manufacturer. The zero numbers are the finer saws. A 000000 blade is the most suitable to use as it will make a very narrow kerf. The narrower the kerf, the better the picture will look when assembled. The jeweler's saw frame is manufactured in different sizes measured by the depth of the frame, and ranges in size up to 18″. The size of the pad being cut will determine the size saw to use; the 5″ frame is suitable for this project.

It is undesirable to saw from the edge of the pad to the outline of the design as the saw kerf is apt to show conspicuously and the strength of the pad will also be reduced. A small hole, just large enough to admit the jeweler's saw blade, is drilled in an inconspicuous corner or curve such as the curve in the lower neckline of the rabbit as shown in Fig. 157. If a No. 60 twist drill is not available, clip the head from a No. 20 wire brad

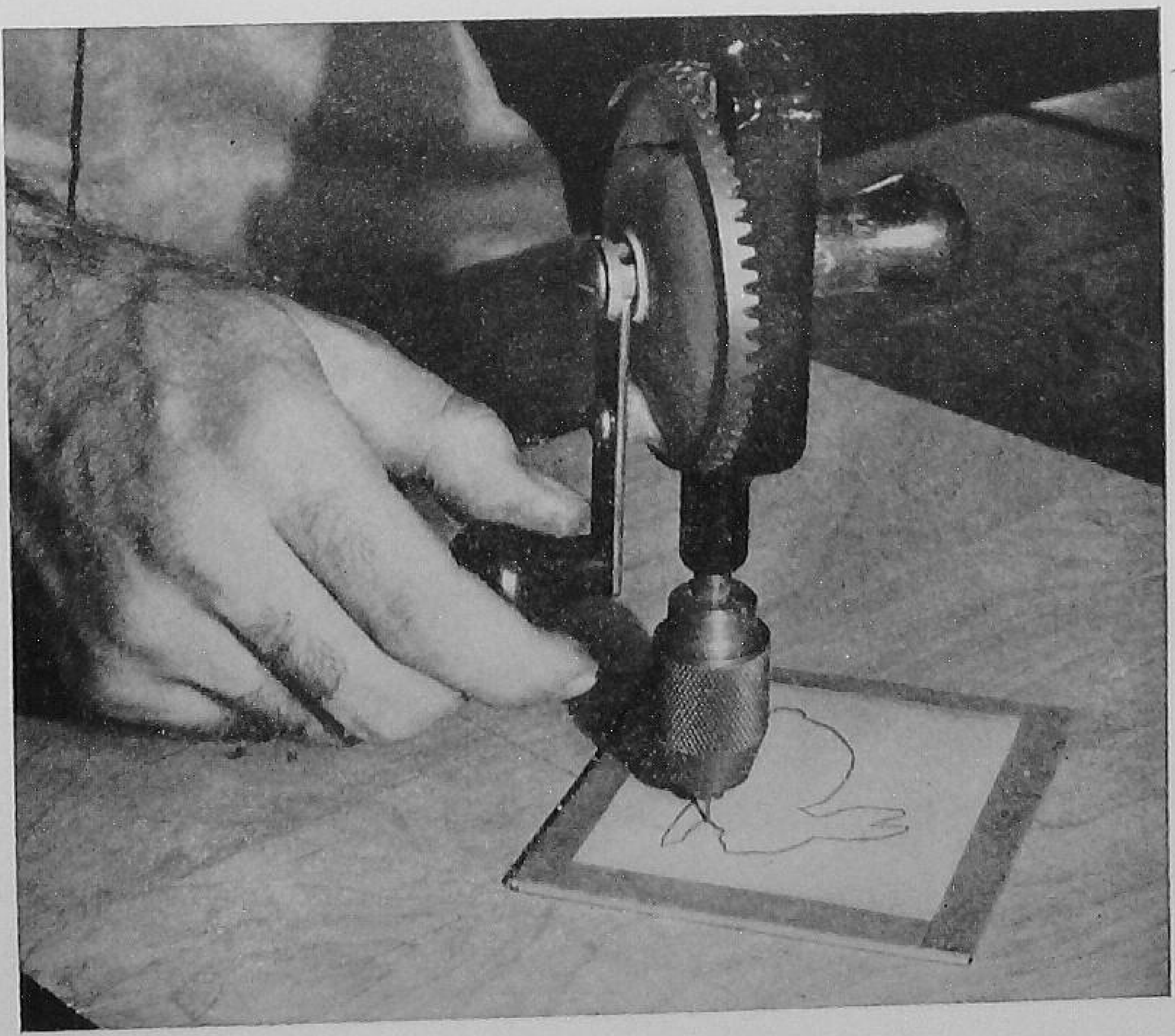


FIG. 157. Drilling through the pad for the saw blade.

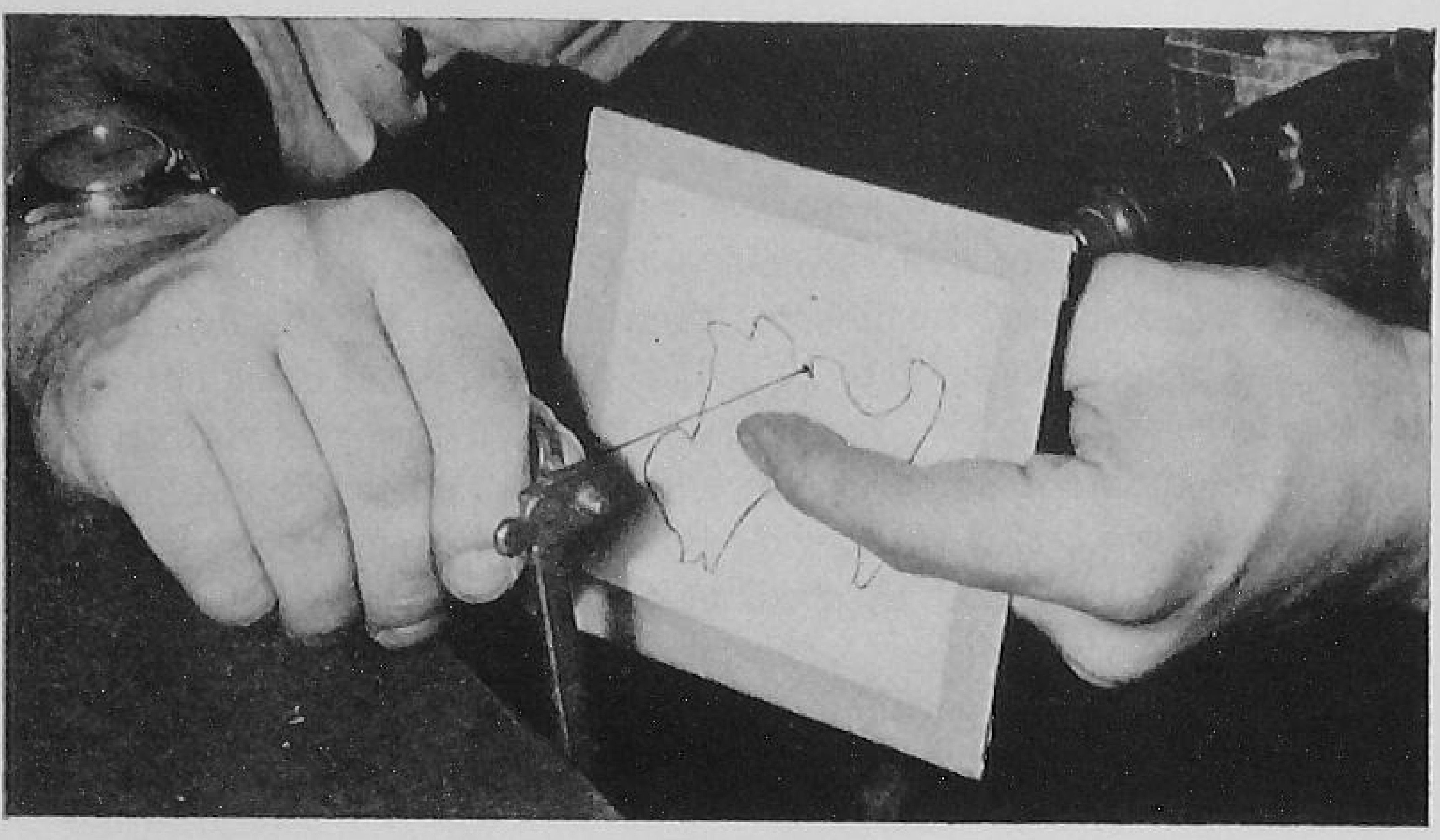


Fig. 158. Inserting the blade through the pad.

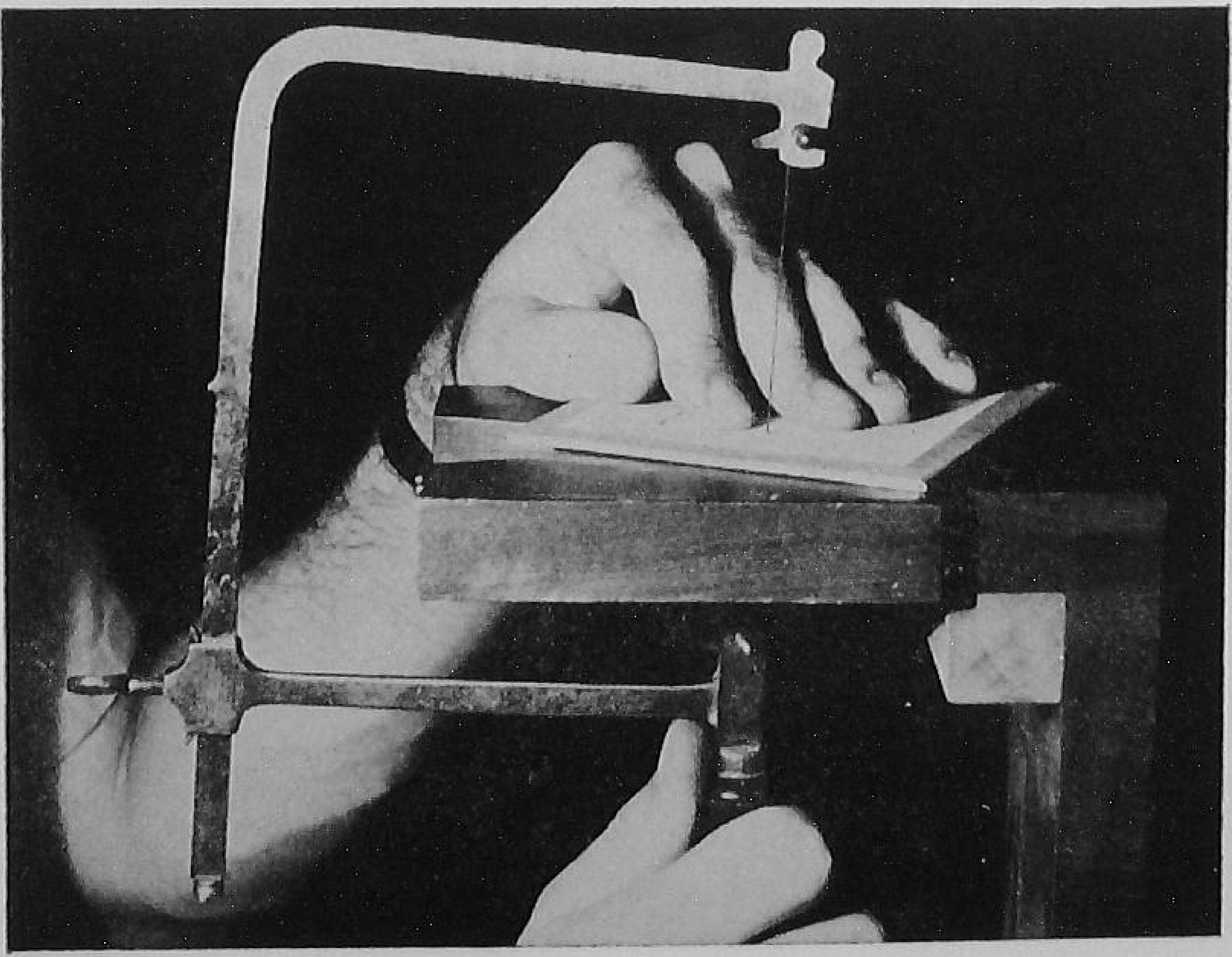


Fig. 159. Sawing the veneer picture.

with a pair of pliers, place the clipped end in the jaws of a hand drill and use the pointed end of the brad as a drill. This is shown in Fig. 157.

One end of the saw blade is fastened in the frame with the teeth pointing toward the handle. Insert the loose end through the hole just drilled (Fig. 158). Tension is then given the blade by pressing one end of the

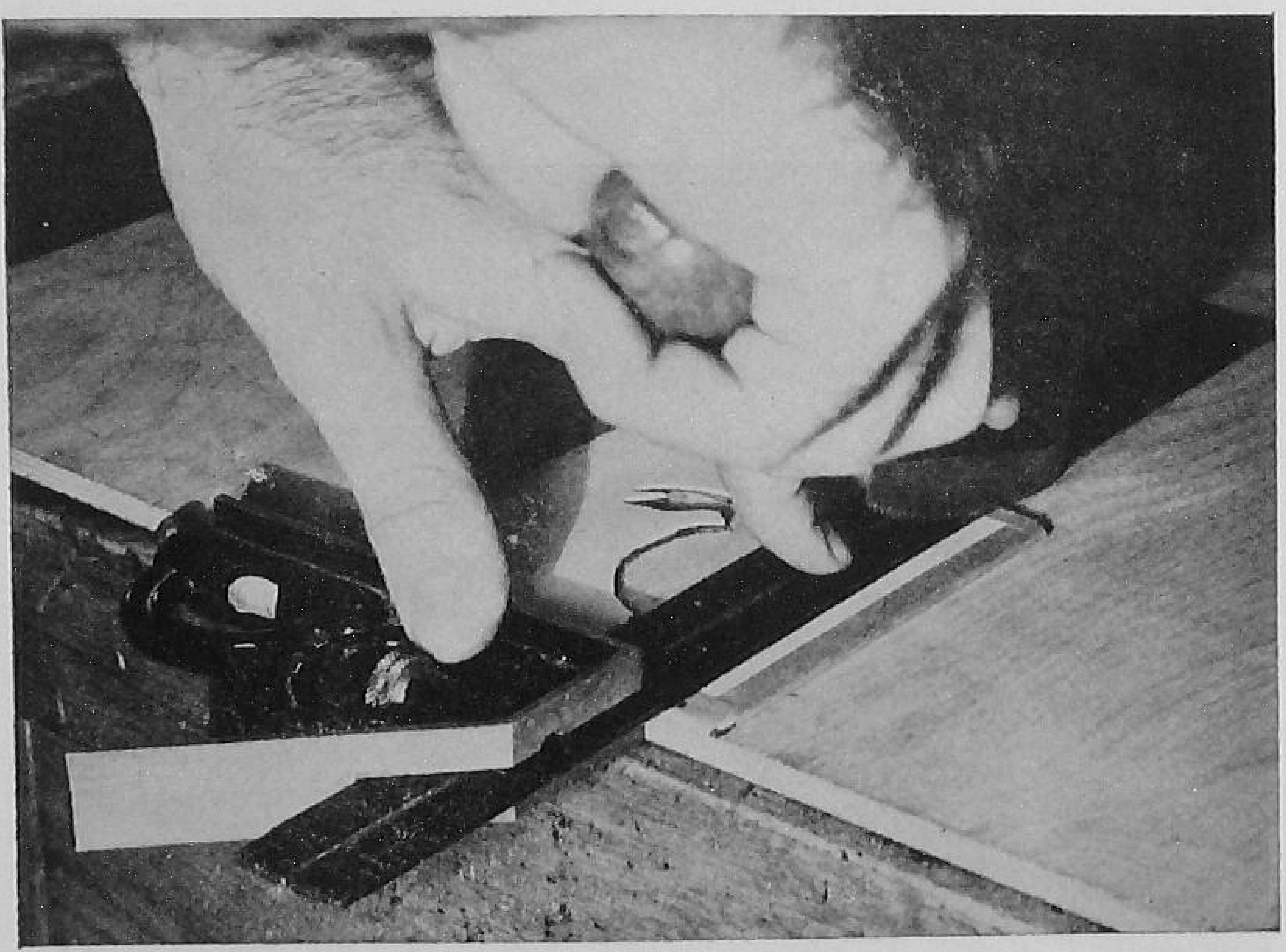


FIG. 160. Trimming the picture to size.

frame against the bench, with the handle against the chest. This leaves both hands free to tighten the blade in the frame as shown.

The pad is now placed on a saw table and the saw held in a vertical position, always at right angles to the pad (Fig. 159). The craftsman should be seated for the sawing operation. The saw is now moved up and down with a 2″ to 2½″ stroke and at the rate of 150 to 200 strokes per minute. The elbow may rest on the thigh for support and the jigging movement is made from the elbow. The other hand is used to hold the pad on the saw table and to turn the pad as necessary. Sawing is done on the line of the design. The blade should not be tilted forward, backward, or sideways as

the pieces cut out will have slant sides and not fit properly. Concentrate on keeping the saw blade vertical, using a smooth steady stroke, and turning the pad with the hand not holding the saw. Jigging should be speeded up when sawing around a small curve or the blade will bind and possibly break. Throughout the entire sawing operation the pad should have the maximum amount of support from the bottom, and to prevent the layers of veneer from buckling in the center, the fingers should keep firm pressure as near the blade as possible.

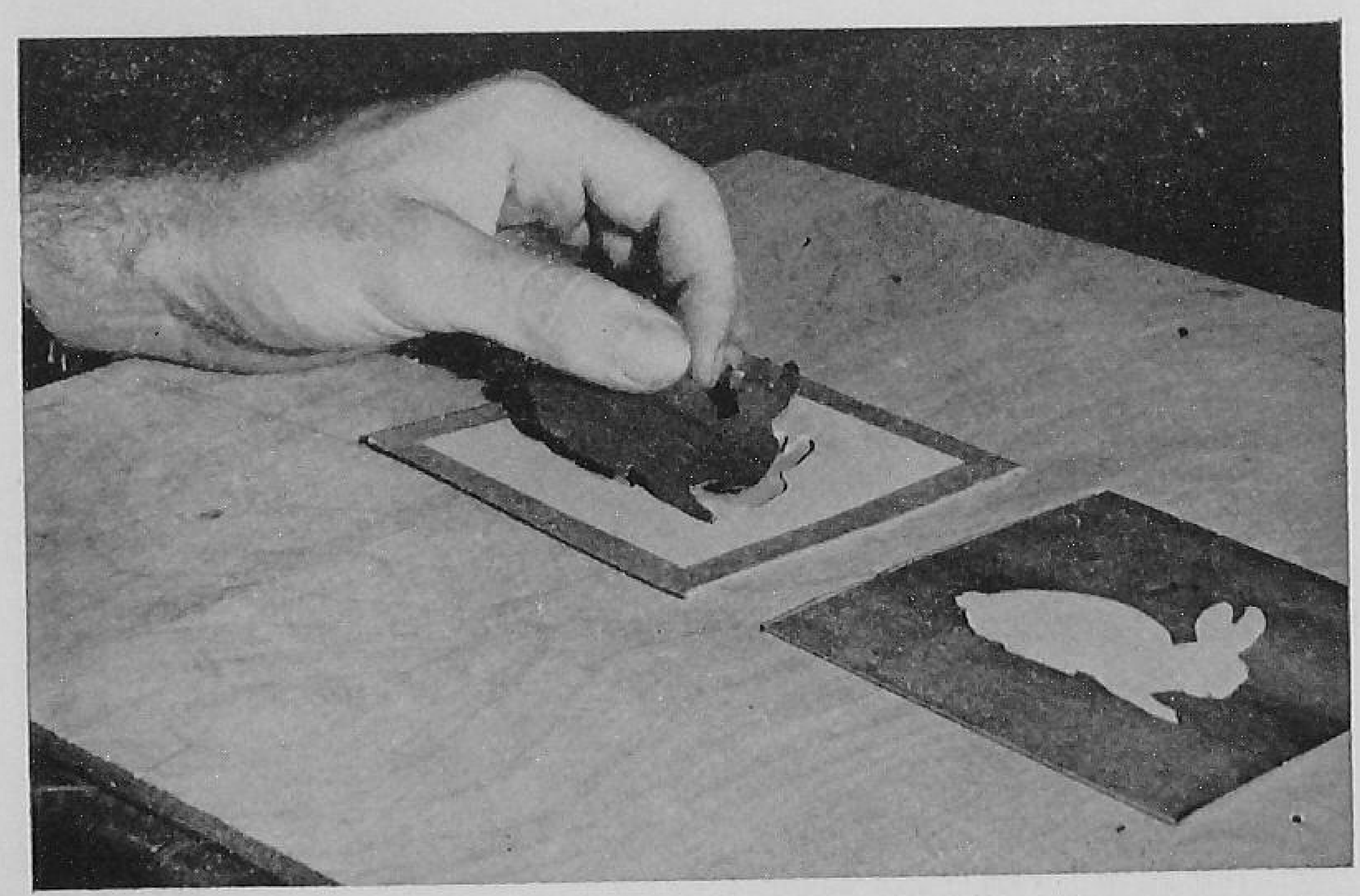


FIG. 161. Assembling the parts of the picture.

5. When the sawing is finished the loosened parts are carefully removed. If any small pieces should break, save them as they can easily be glued in place before finishing. The edges of the pad are now trimmed to exact finished dimensions with the veneer saw as shown in Fig. 160. Remove any of the gummed tape remaining.

6. Now lay the two background pieces of veneer on the bench and place the design of contrasting colored wood in the opening, as in fitting parts for a jigsaw puzzle (Fig. 161). The worker can then decide which he prefers for the finished picture.

7. The pieces of the picture should now be fastened firmly together for easier handling. This can be done by pasting small pieces of gummed tape across the sections of the picture, or by the method shown in Fig. 162. The surface of a piece of paper is coated with rubber cement and the pieces of veneer are cemented to the paper, face down. In other words, the surface of the picture which will be exposed when the project is completed is now covered with paper which will be removed later.

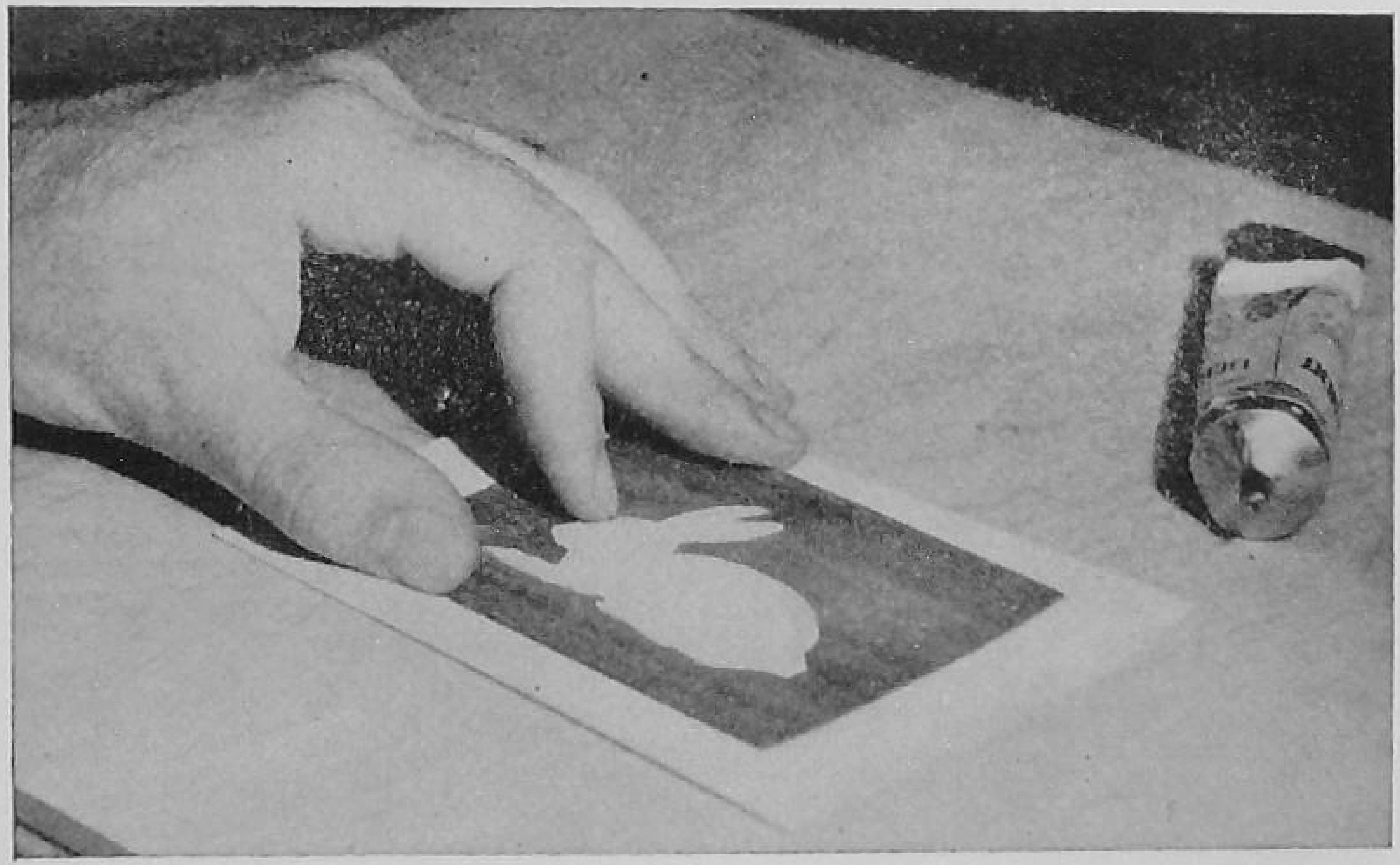


FIG. 162. Pasting the picture on paper backing.

8. At this stage, an additional step may be taken which is not shown in the completed picture of the rabbit but is shown in several of the pictures following. This is the application of a border and may be done by several methods. To obtain a satisfactory corner, it is necessary to cut a miter, or angle of 45 degrees, on the end of each piece of border material. Two pieces of border veneer are cut for the sides and two pieces for the ends of the picture. The side pieces are cut to the length of the picture, plus twice the width of the veneer border. If the picture is to be 5″ long and the veneer border is ⅛″ wide, then the two side pieces are cut 5¼″ long. The same procedure is followed in measuring the pieces for the ends of the picture.

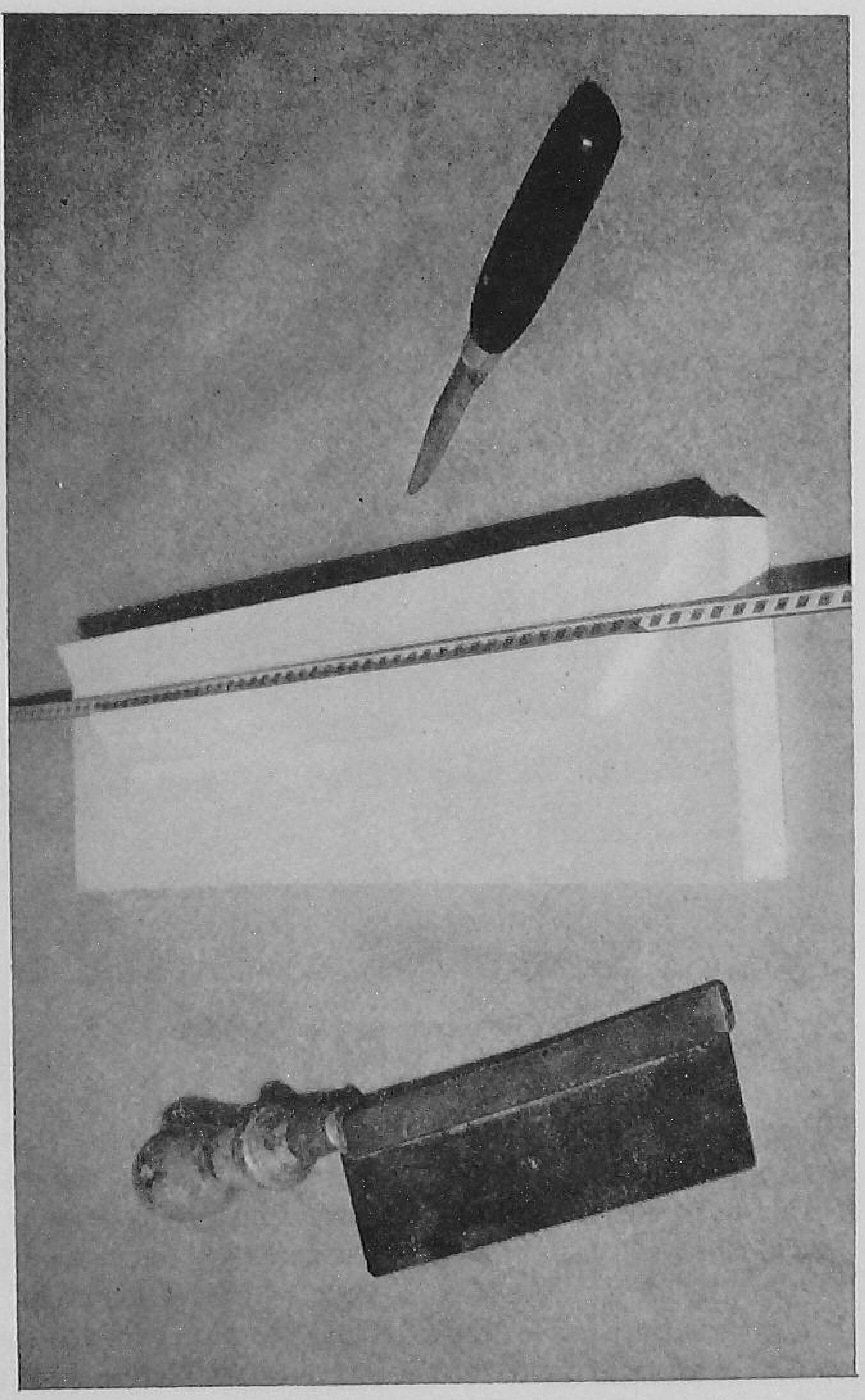


FIG. 163. Miter-cutting board.

A cutting board as shown in Fig. 163 may be made to act as a guide for either a knife or a small saw in cutting the miter. Fig. 164 shows a saw being used and Fig. 165 shows a knife being used with the cutting board.

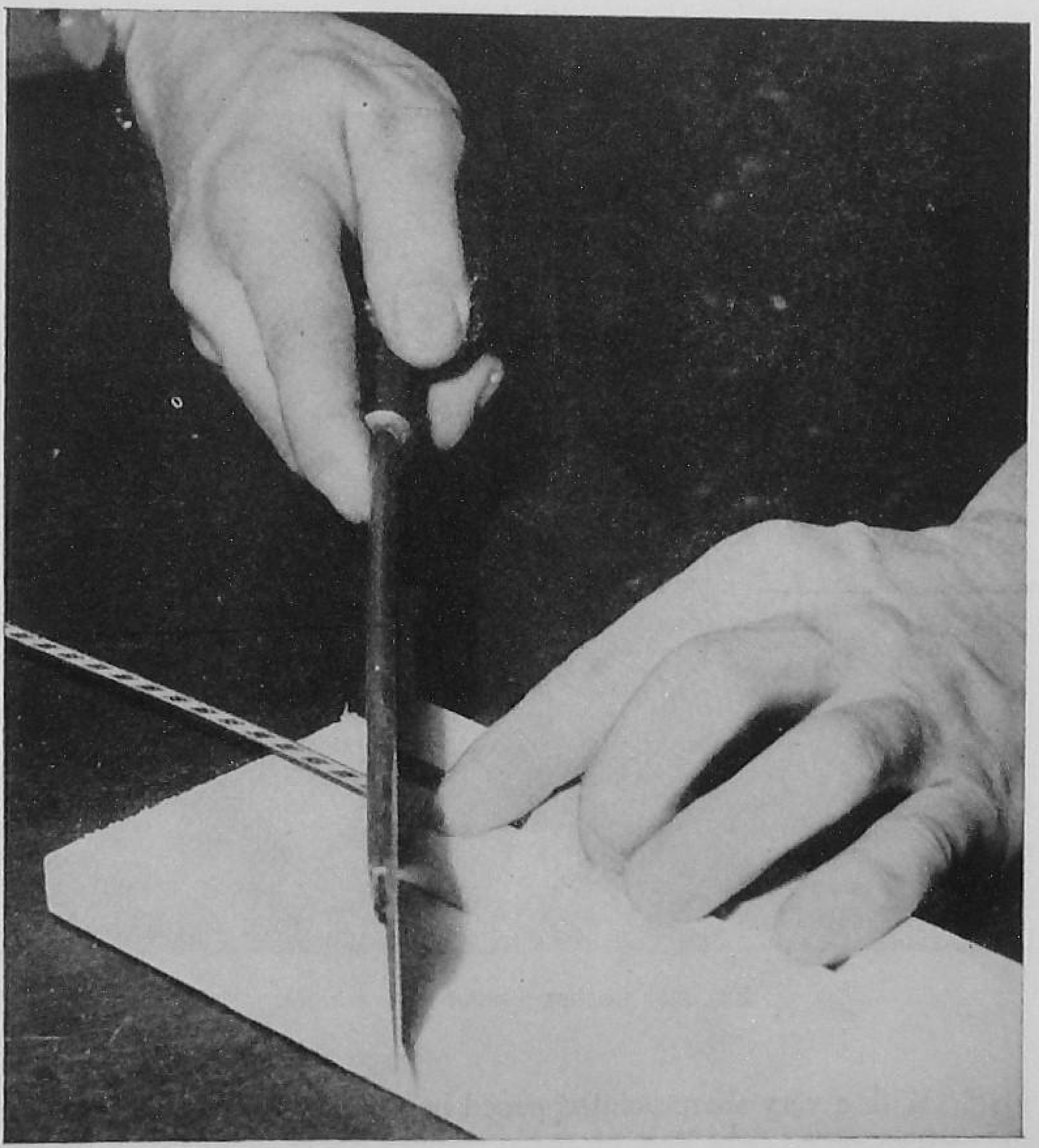


Fig. 164. Cutting a miter with a fine saw.

If it is not desired to use a cutting board as a guide, the blade of a combination square may be used as the guide, shown in Fig. 166.

When the border pieces are cut, they are cemented to the paper with rubber cement in the same manner as the picture.

9. The worker must now decide whether he intends to use the veneer picture as an inlay and recess it into the surface of a piece of wood, or use it as a veneer, or overlay, on the surface of a piece of wood.

In order to set the veneer picture into the surface of a piece of wood it will be necessary to lay the picture, paper side up, on the center of the wood. With a very sharp-pointed pencil held tightly against the edges of the picture, scribe light lines on the surface of the piece of wood. With a straightedge for a guide, cut straight down on the pencil lines with the point of a sharp knifeblade. A router plane is used to remove the excess wood as shown in Fig. 167. The routing is done to a depth slightly less than the thickness of the veneer picture. The bottom of the recess should be flat but not sanded smooth. Care must be taken to keep the sides of the recess straight and square.

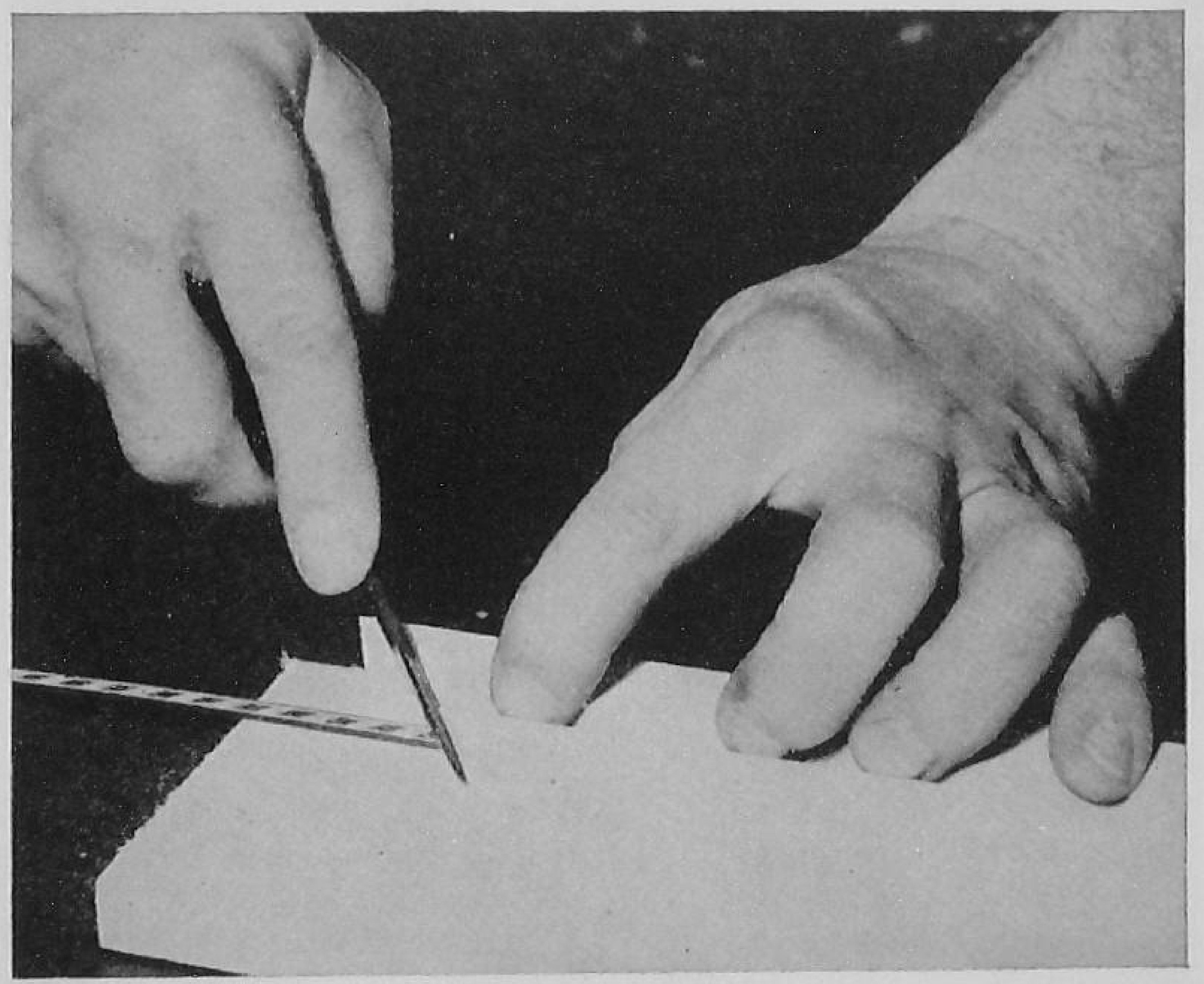


FIG. 165. Cutting a miter with a knife.

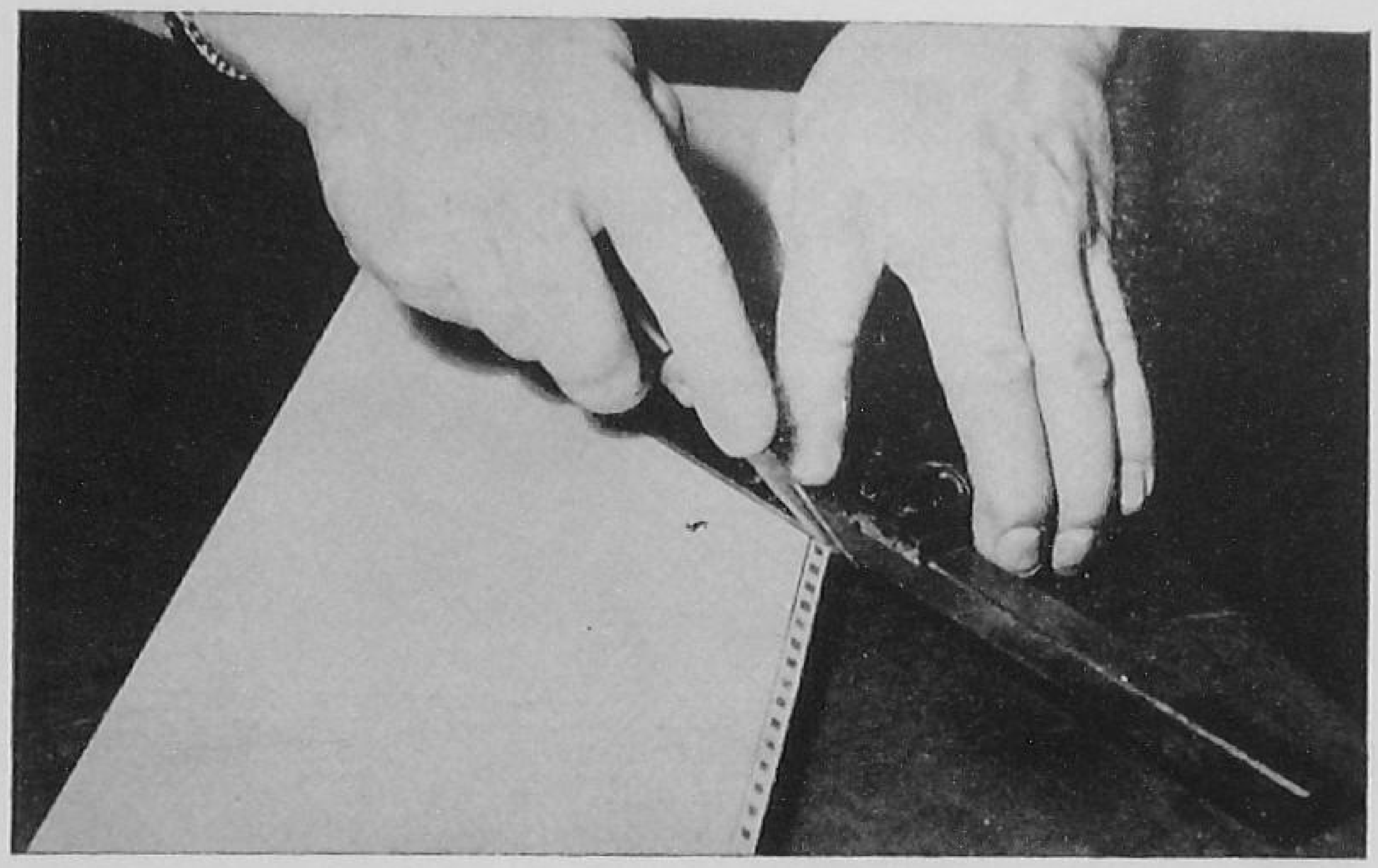


FIG. 166. Cutting a miter with a knife and combination square.

FIG. 167. Using a router plane.

If it is desired to glue the picture on the surface of a piece of wood, the routing process is not necessary. A piece of ¼-inch plywood is cut to

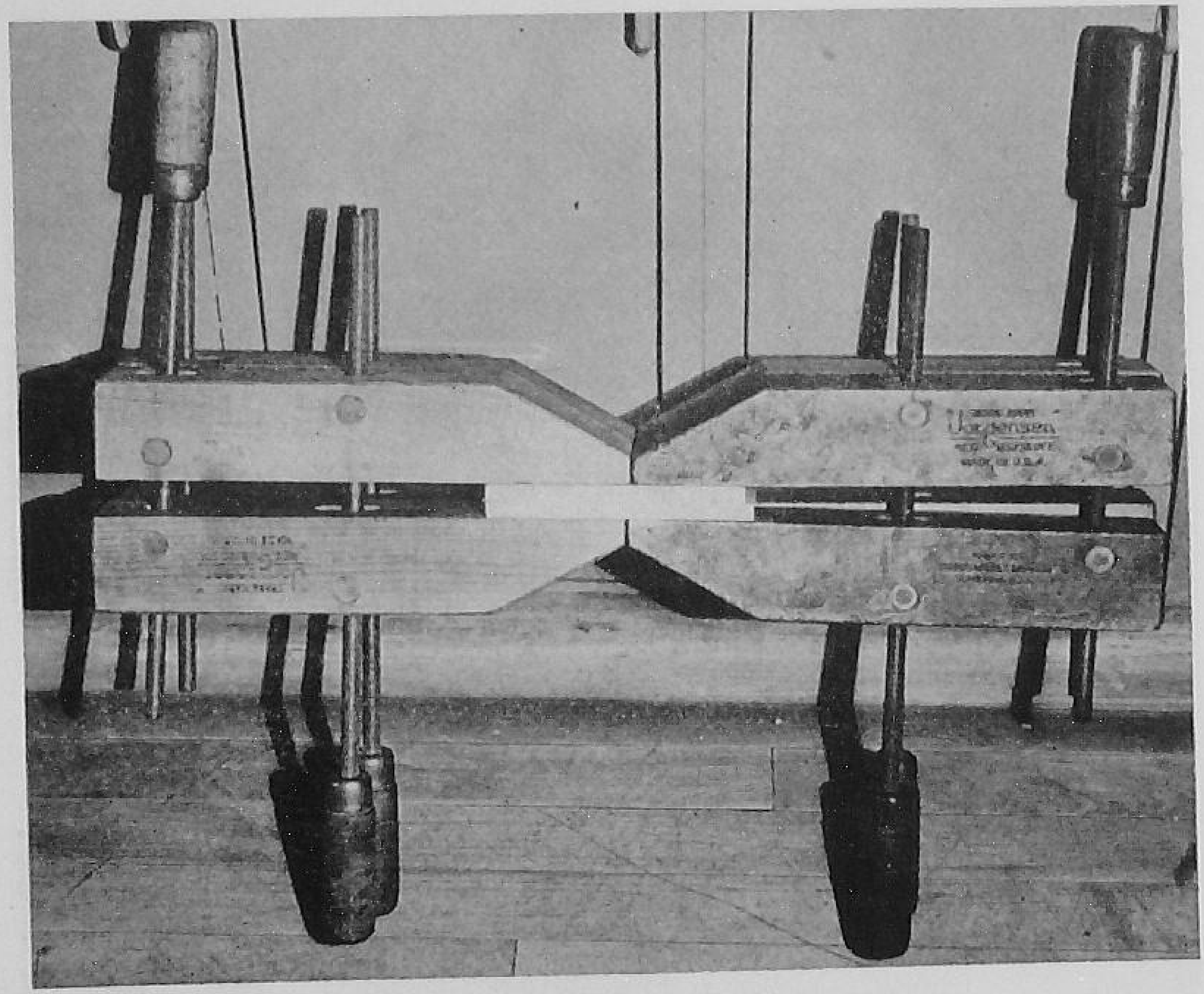


FIG. 168. Clamping the glued veneer.

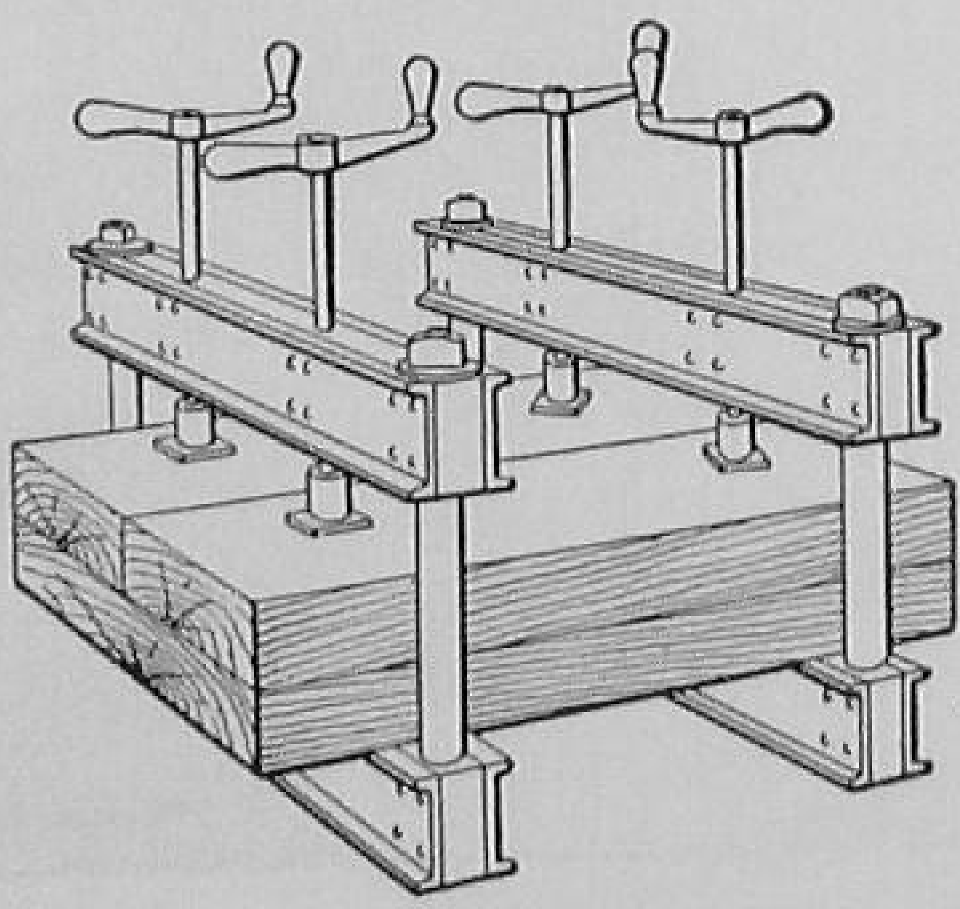


FIG. 169. Veneer clamp.

the size of the picture and the veneer is glued directly to the surface of the plywood.

10. Using a good grade of liquid glue, brush a light coat in the bottom of the recess. Make sure that the glue is spread evenly and reaches all

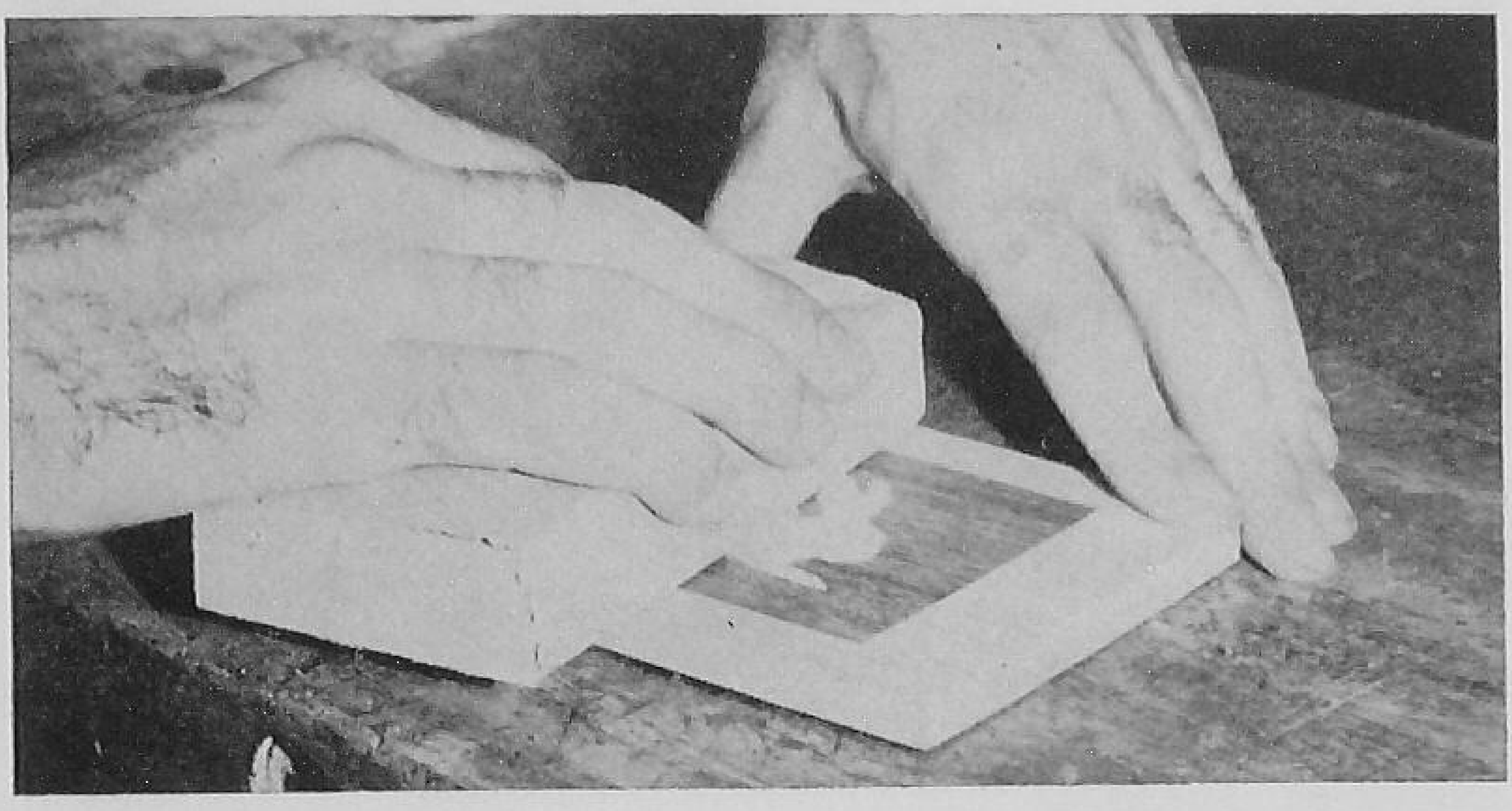


FIG. 170. Sanding the completed picture.

parts of the recess. Place the picture in the recess with the paper side up. Over the paper, place a piece of scrap wood with a flat surface lying on the paper. Pressure is now applied either by woodworker's clamps as shown in Fig. 168, a veneer clamp (Fig. 169), or by placing weights on the scrap piece of wood. The pressure must be uniform and applied for 24 hours to insure complete drying of the glue.

11. After removing the clamps, remove all paper from the surface of the picture. This can be done by lightly dampening the paper with a moist cloth and scraping the softened paper lightly with a knife blade. Now sand the entire surface of the picture with 2/0 sandpaper (Fig. 170). Be sure and sand in the direction of the grain to prevent scratches. When the surface is level and smooth, finish sanding with 4/0 sandpaper, dust lightly and finish by applying several coats of white shellac. Figs. 171 and 172 show applications of the above inlaying process to several projects. Figs. 173 and 174 show the process applied to pictures which have been veneered or overlayed on pieces of plywood to complete the pictures for use as wall

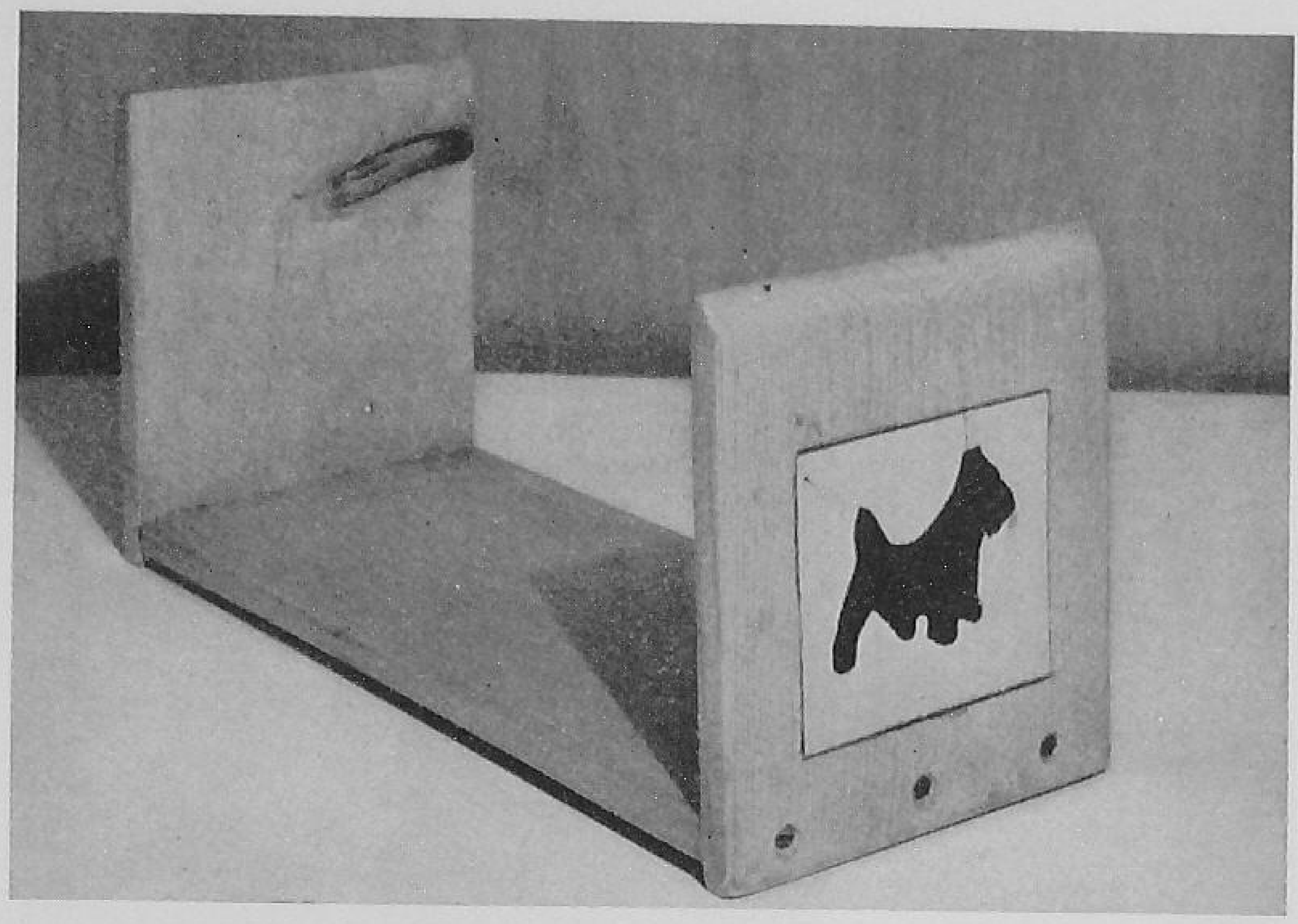


FIG. 171. Picture inlayed on book rack.

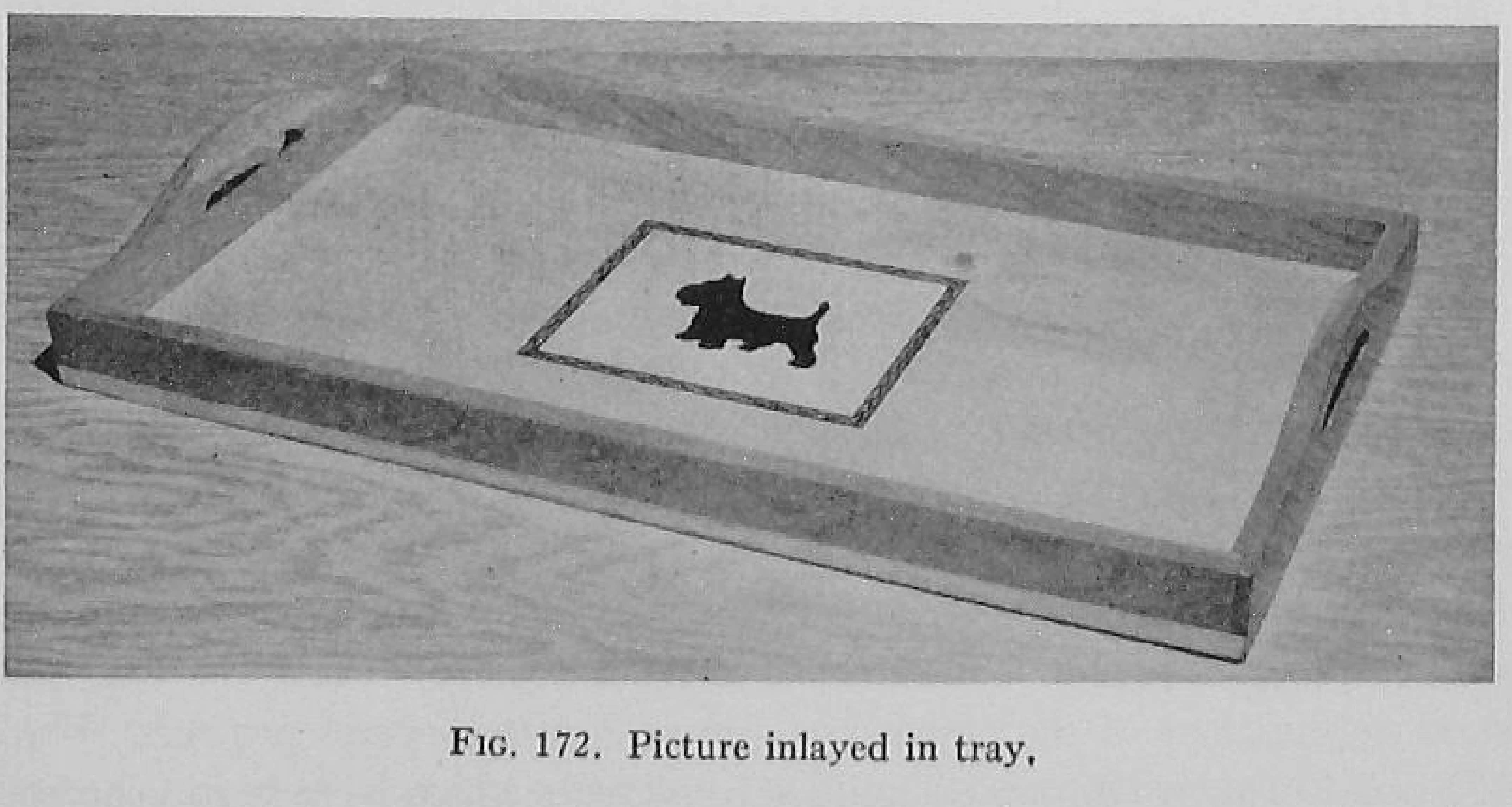


FIG. 172. Picture inlayed in tray.

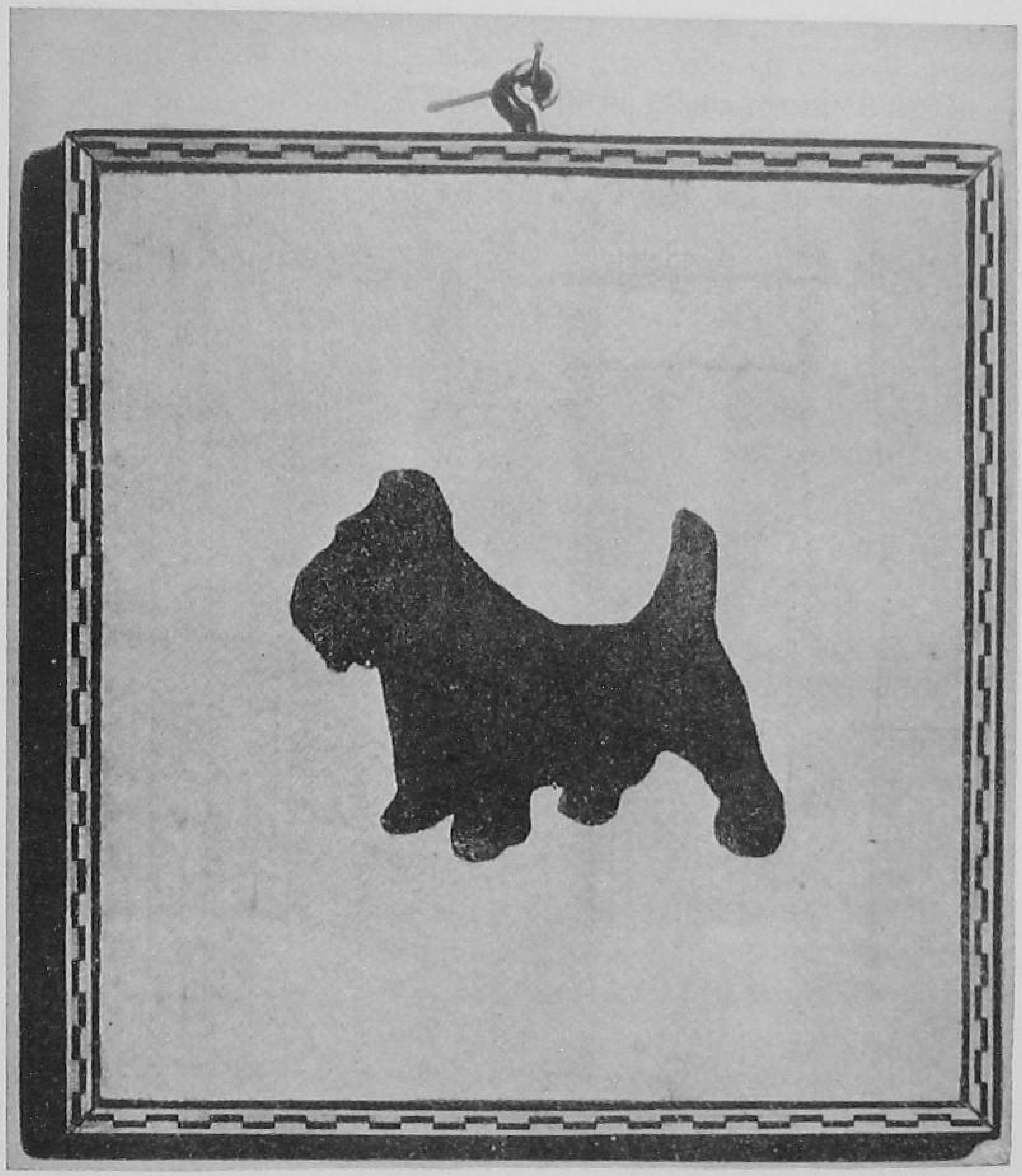


Fig. 173. Picture veneered over a piece of plywood.

placques. This effect of such pictures may be varied by applying a picture-frame molding to the edges of the veneered picture. Full-size drawings of the figures for these pictures are illustrated.

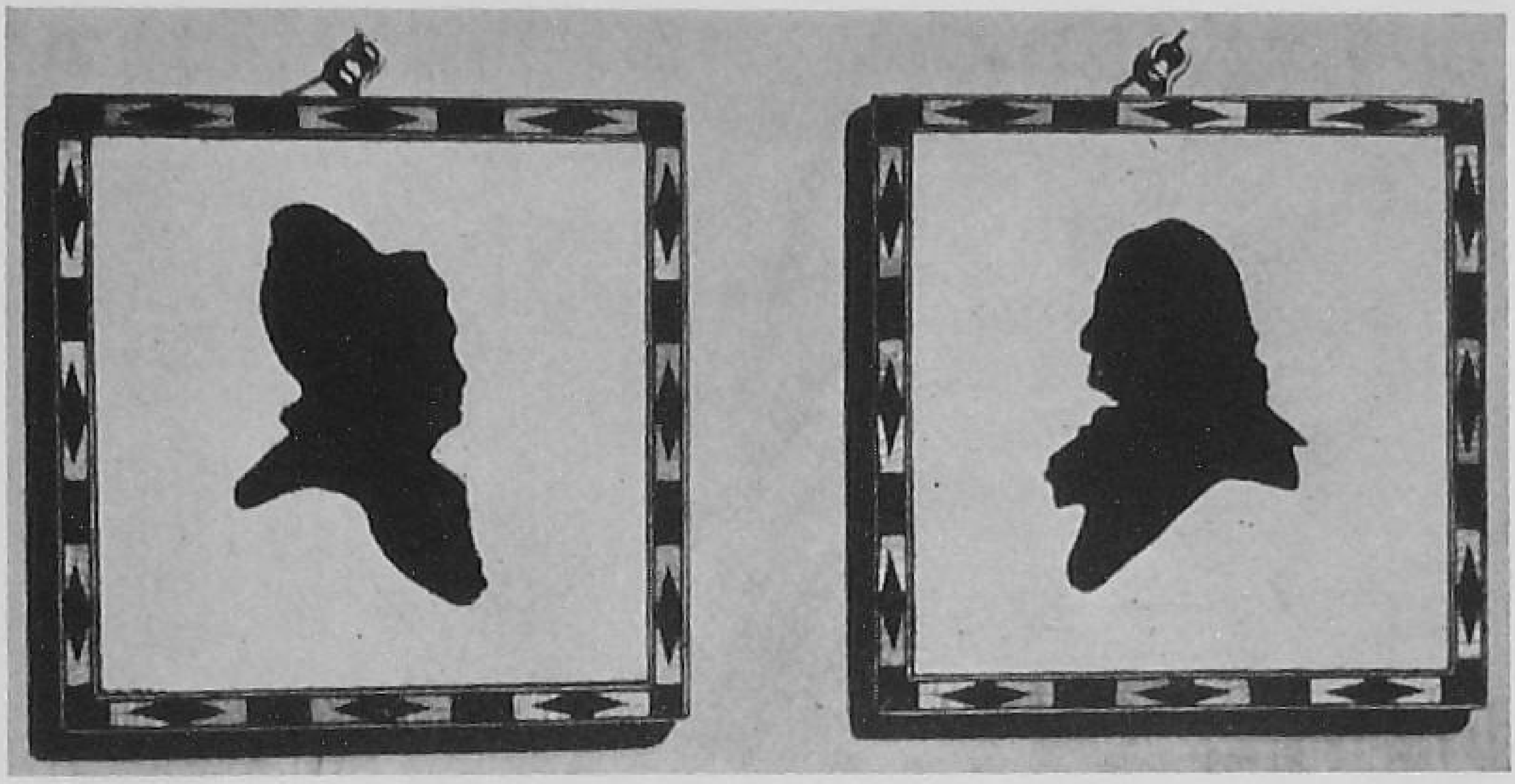


FIG. 174. Veneered wall plaques.

Note: Suppliers of Veneers, Tools and Materials

H. L. Wild Co., 510 East 11 Street, New York 9, N. Y.
Albert Constantine and Son, Inc., 797 East 135 St., New York, N. Y.
Brodhead-Garrett Co., Cleveland, Ohio (Tools & Materials)

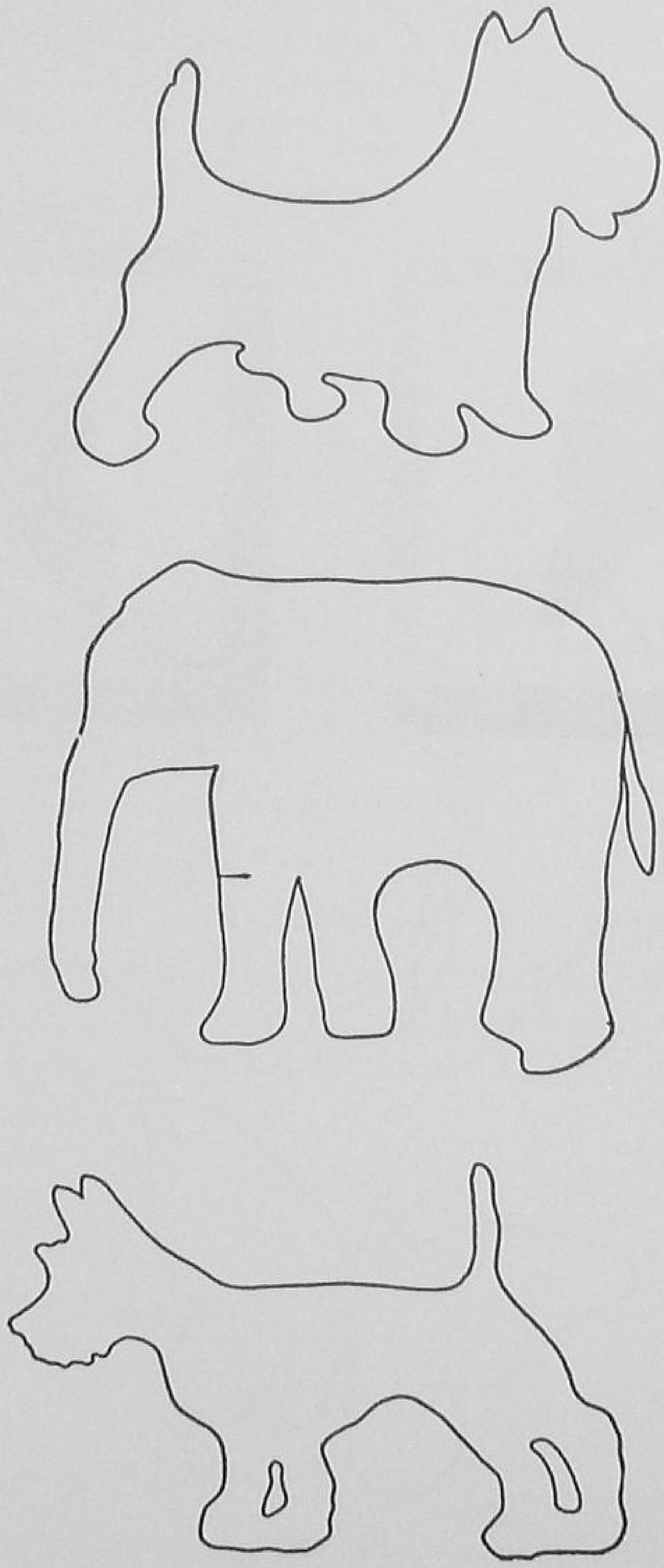


FIG. 175.

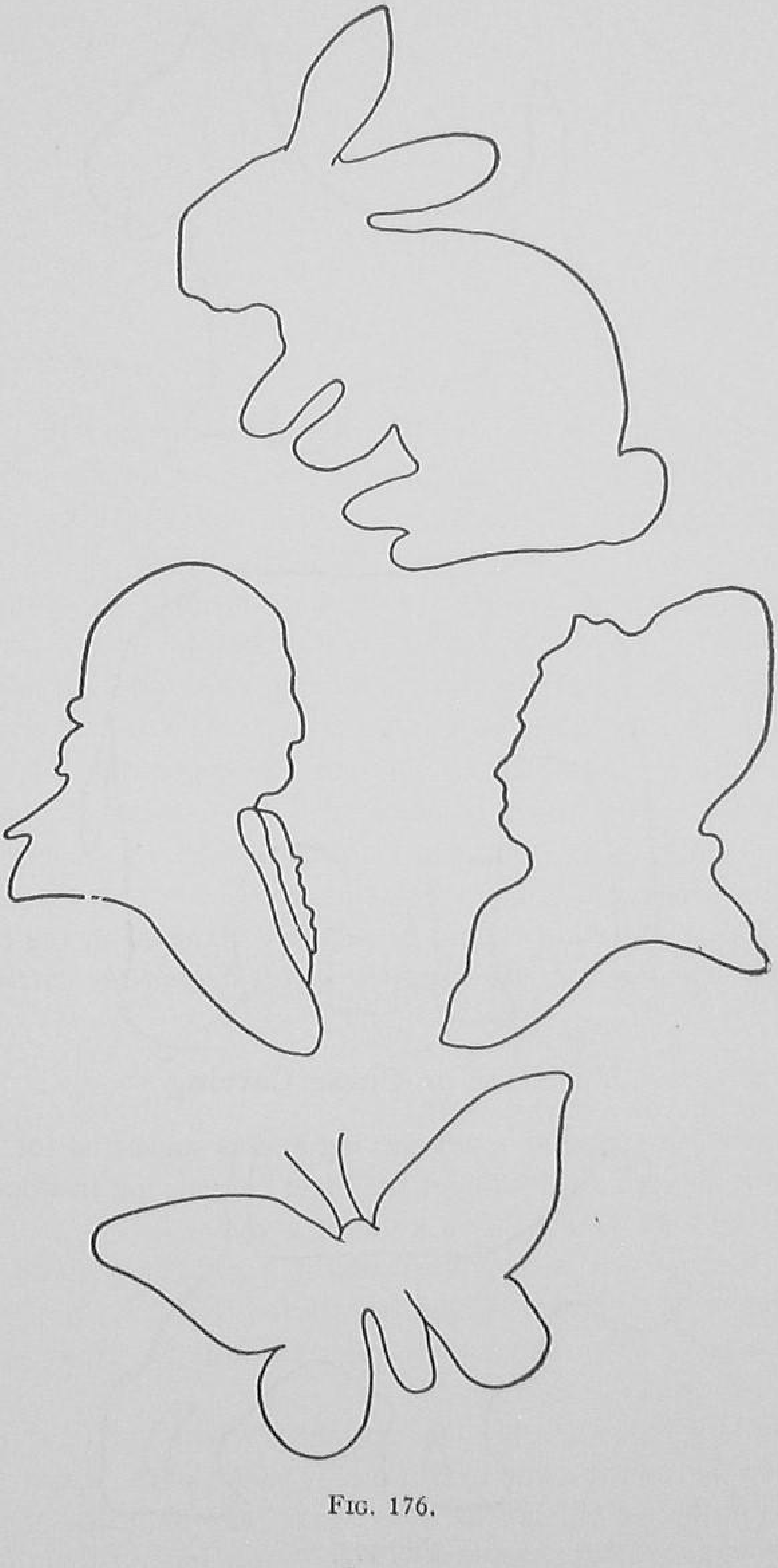


FIG. 176.

Chapter V

WOOD CARVING

Wood carving is a craft that can be enjoyed by anyone with a minimum number of tools. It is much less difficult than most people believe. This chapter does not cover all phases of carving but endeavors to introduce the handicraft worker to a few basic steps so that he can decorate the projects he desires to make. Wood carving is a means of decorating objects made of wood to improve and beautify the natural wood. It gives the handicrafter an opportunity to express his own interpretation of ideas.

This chapter will not present specific projects in wood carving but will, rather, illustrate by pictures and diagrams the application of the various types of carving. The woods recommended for carving are the same as those for whittling, although as the handicrafter becomes more skilled he should try working with different kinds of wood.

For all carving, the work should be securely clamped to the bench. *Always work with sharp tools and keep the hands behind the cutting edge.*

I. Incised or Chase Carving

This is the easiest type of wood carving and is suggested for the beginner as it gives an opportunity to get the "feel" of carving in wood. Incised carving may be done with either a knife or a veiner.

A simple design, such as that illustrated in Fig. 177, is traced on a piece of tracing paper. The design is then transferred to the surface of the wood by placing a piece of carbon paper under the tracing paper and using a sharp pencil to trace the design.

The knife (Fig. 178) is held in an upright position and a cut about 1/16" deep is made right on the line. The knife is then slanted about 15 degrees and a cut is made just outside the line, away from the inside of the design. This should remove a thin shaving (Fig. 179). Always cut in the direction of the grain.

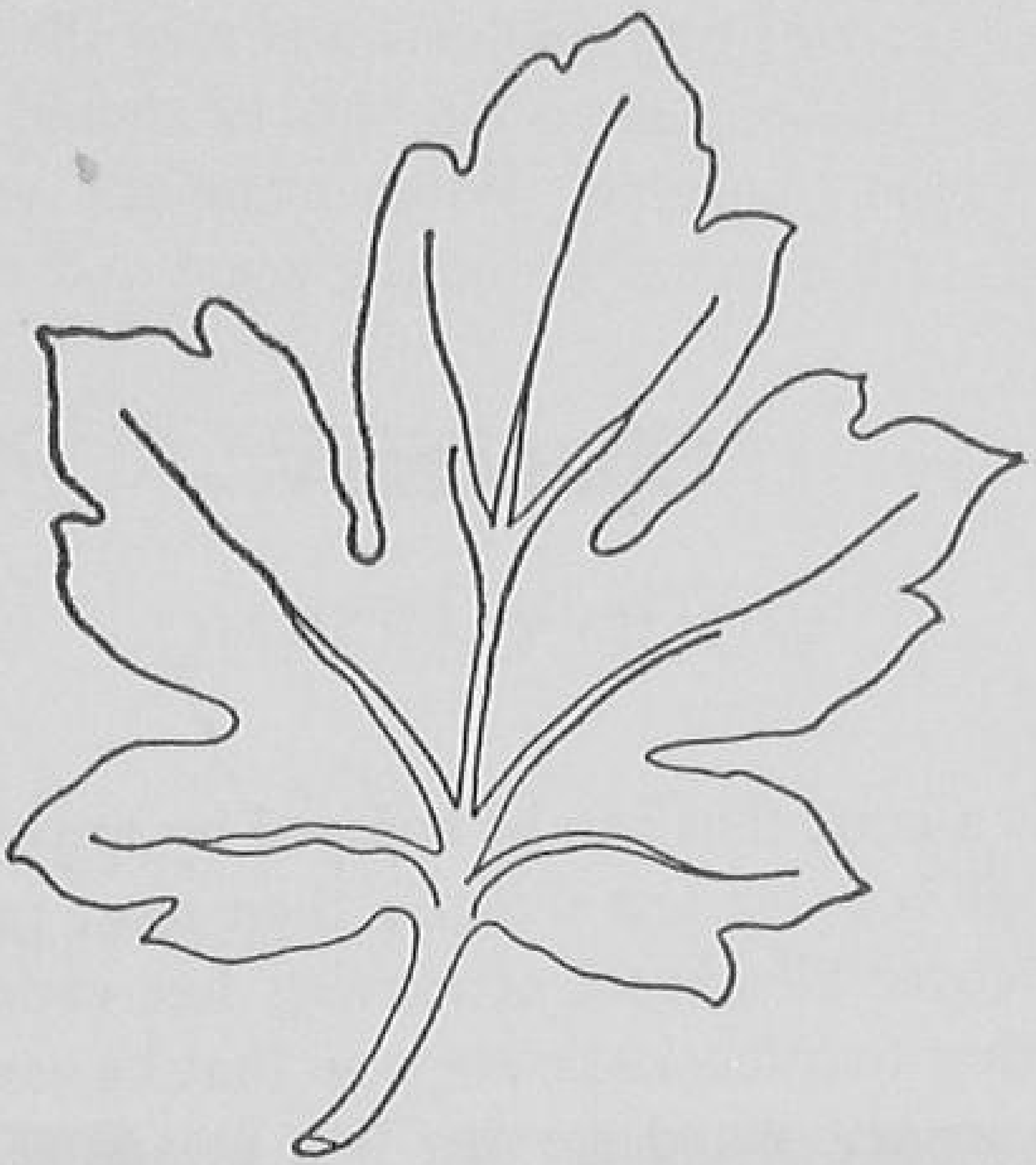


FIG. 177. Simple leaf design.

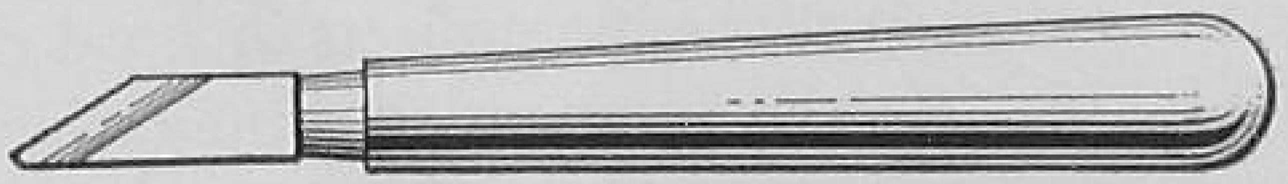


FIG. 178. Carving knife.

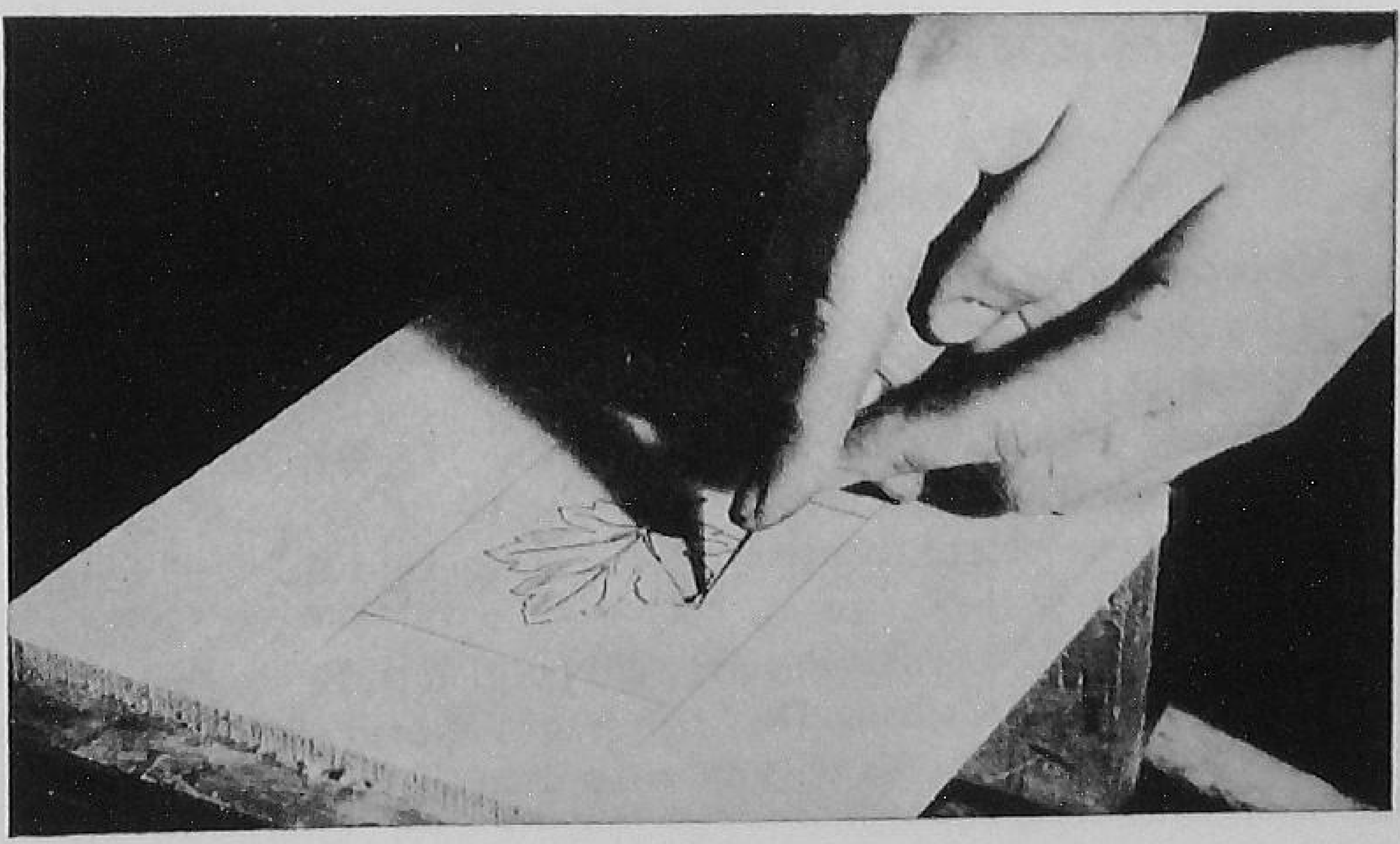


FIG. 179. Incising lines with a knife.

If the veiner or V-parting tool (Fig. 180) is used the cut is made directly on the line (Fig. 181). Long sweeping strokes should be used which will remove a thin sliver-like shaving. When using the veiner, the tool may have a tendency to follow the grain of the wood and waver from the outline of the design. This may be prevented by first cutting a "stop-cut" on the lines with a knife. If the tool tears the wood when cutting across the grain, it may be an indication that the tool needs sharpening.

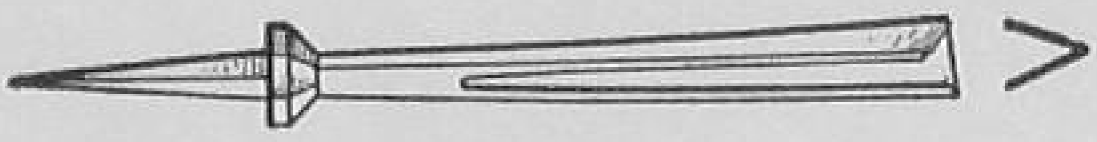


FIG. 180. Veiner.

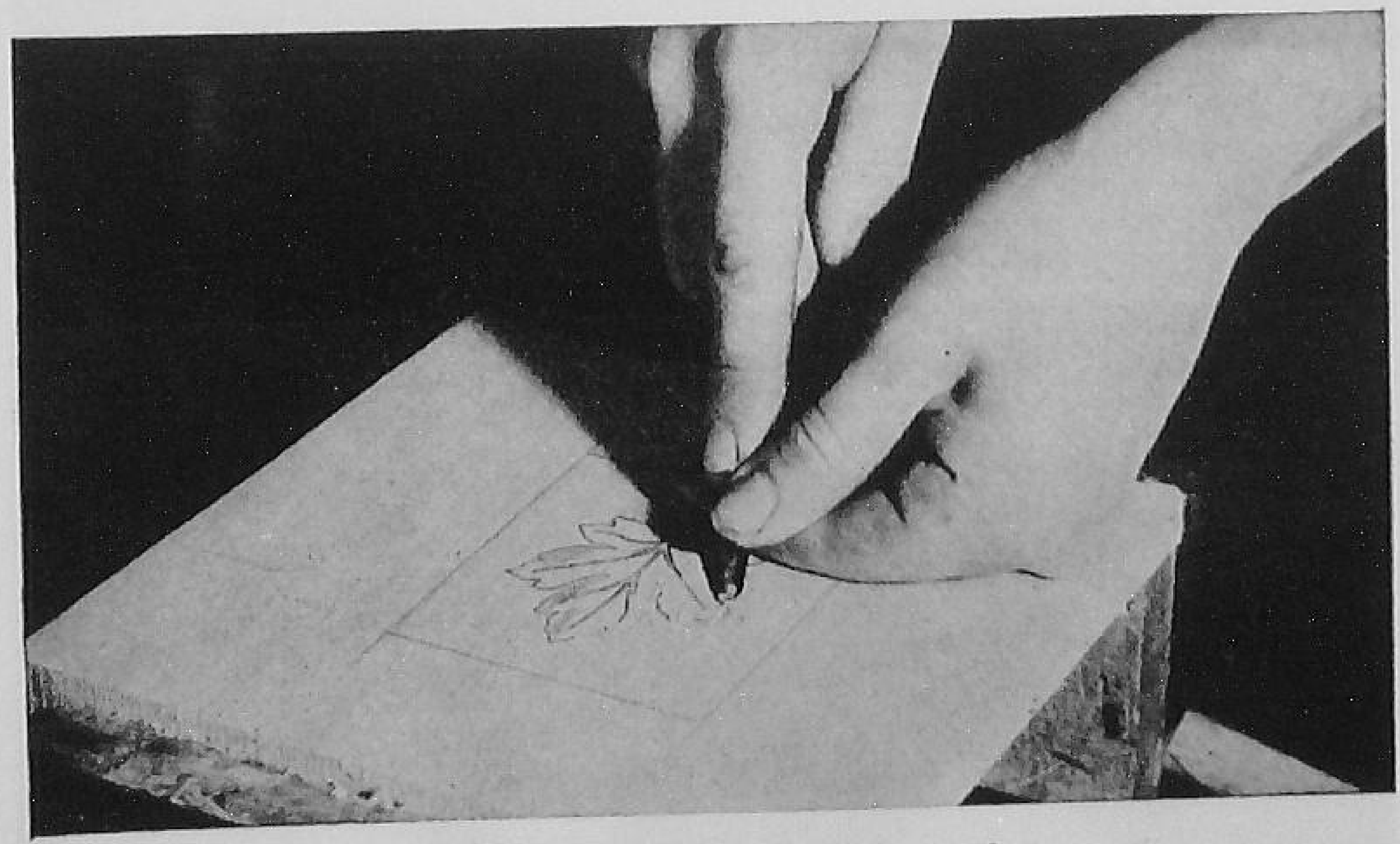


FIG. 181. Incising with veining tool.

The carving may be left with a plain background, or the background may be "threaded-in" or "stippled." Threading-in is done with the V-tool (Fig. 182), or it may be done with a knife, in the same way that the design was cut. Stippling is done with a punch (Fig. 183) which may be purchased in different sizes and patterns. A punch may easily be made by taking a piece of ¼″ square mild steel and cutting a series of shallow grooves across one end with a hack saw or file. The grooves may be cut in

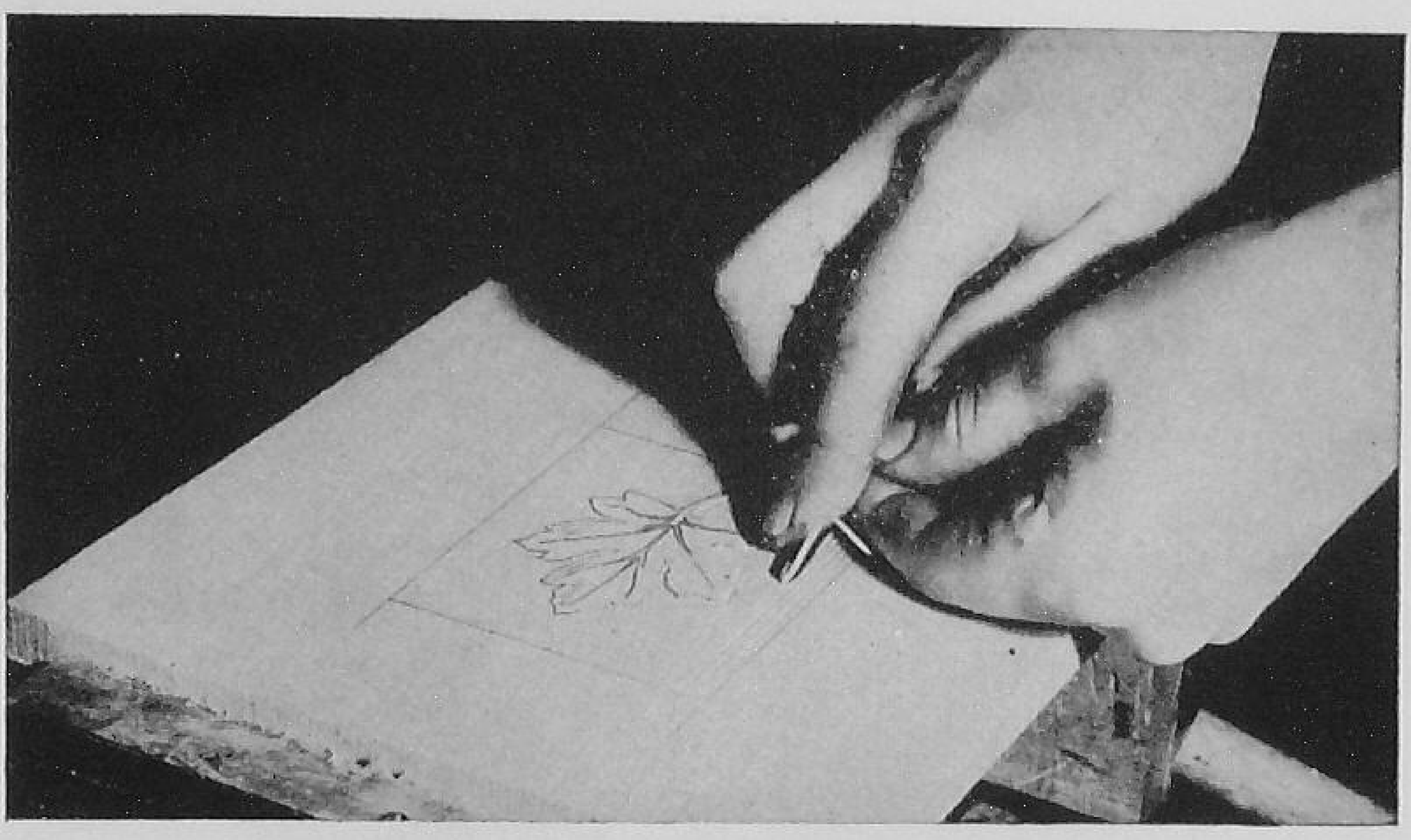


Fig. 182. "Threading-in" with veining tool.

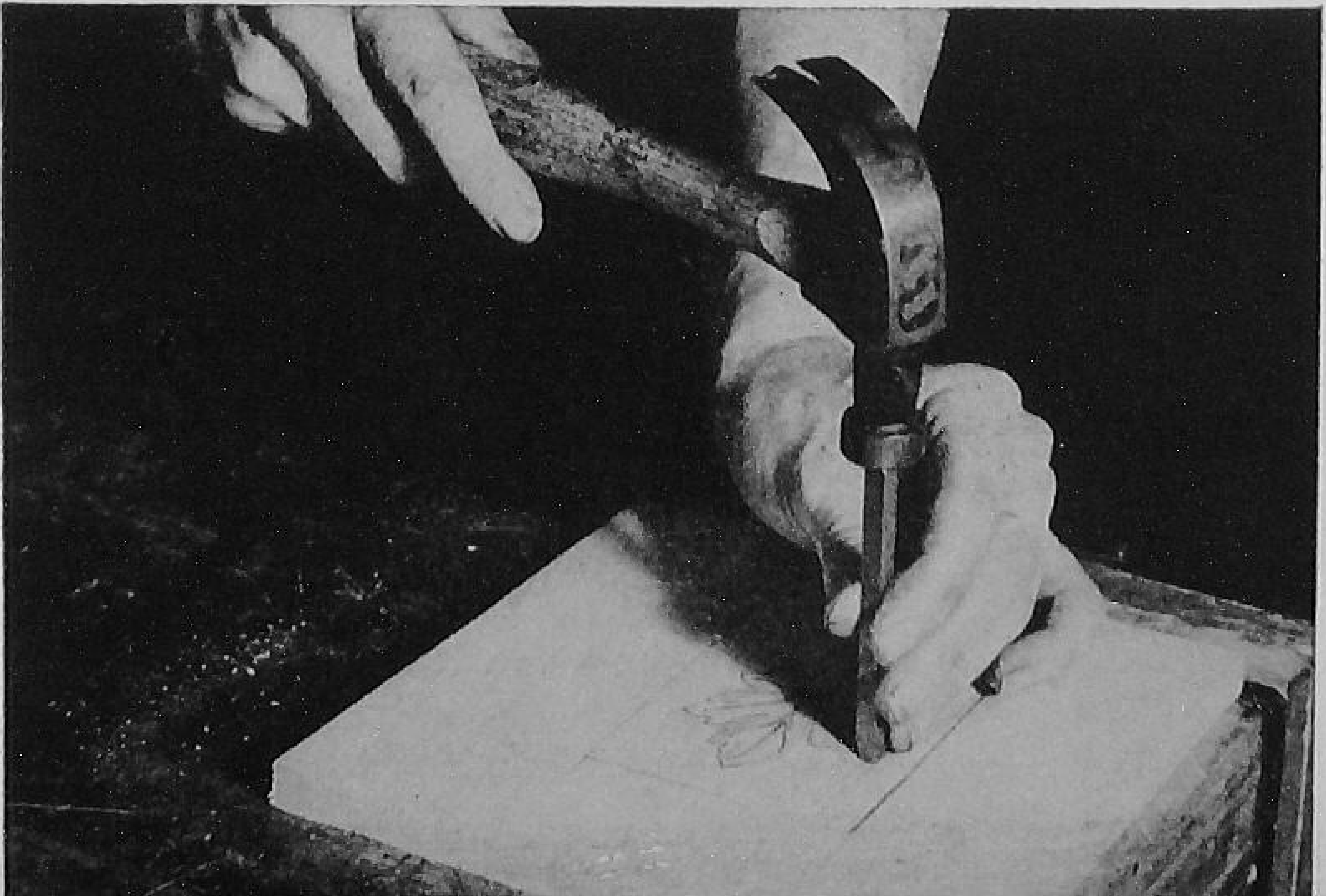


Fig. 183. Stippling the background.

various patterns to provide different stippled backgrounds. If the mild steel is not available, satisfactory results can be obtained by making the pattern on the end of a large nail.

FIG. 184. Example of a stippled background. Background and surface have natural finish.

After the carving has been completed, the surface of the wood is sanded, with the sandpaper being wrapped around a wooden block. The carved lines are thoroughly dusted and the finish applied. Various effects are produced by coloring the carved design and having the surface wood natural (Fig. 184) or of a different color. Another effect can be obtained by apply-

ing a coat of shellac in the carved lines with a fine camel's-hair brush. When the shellac dries, the surface wood may be stained, leaving the carved design in the natural color of the wood. When stippling is done in the background, the background may be stained darker than the carved lines by rubbing an oil stain over the entire surface. The stain will darken the stippled area more than the surface wood causing the carved design to stand out (Fig. 185).

The drawing of the letter holder in Chapter III provides a nice beginning project for incised carving.

Fig. 185. Background is stained darker than surface.

II. Chip Carving

Chip carving is another form of carving which requires a minimum of tools but is excellent for giving the handicrafter practice in acquiring the feel of the wood while it is being cut. Several types of knives are available as shown in Fig. 186.

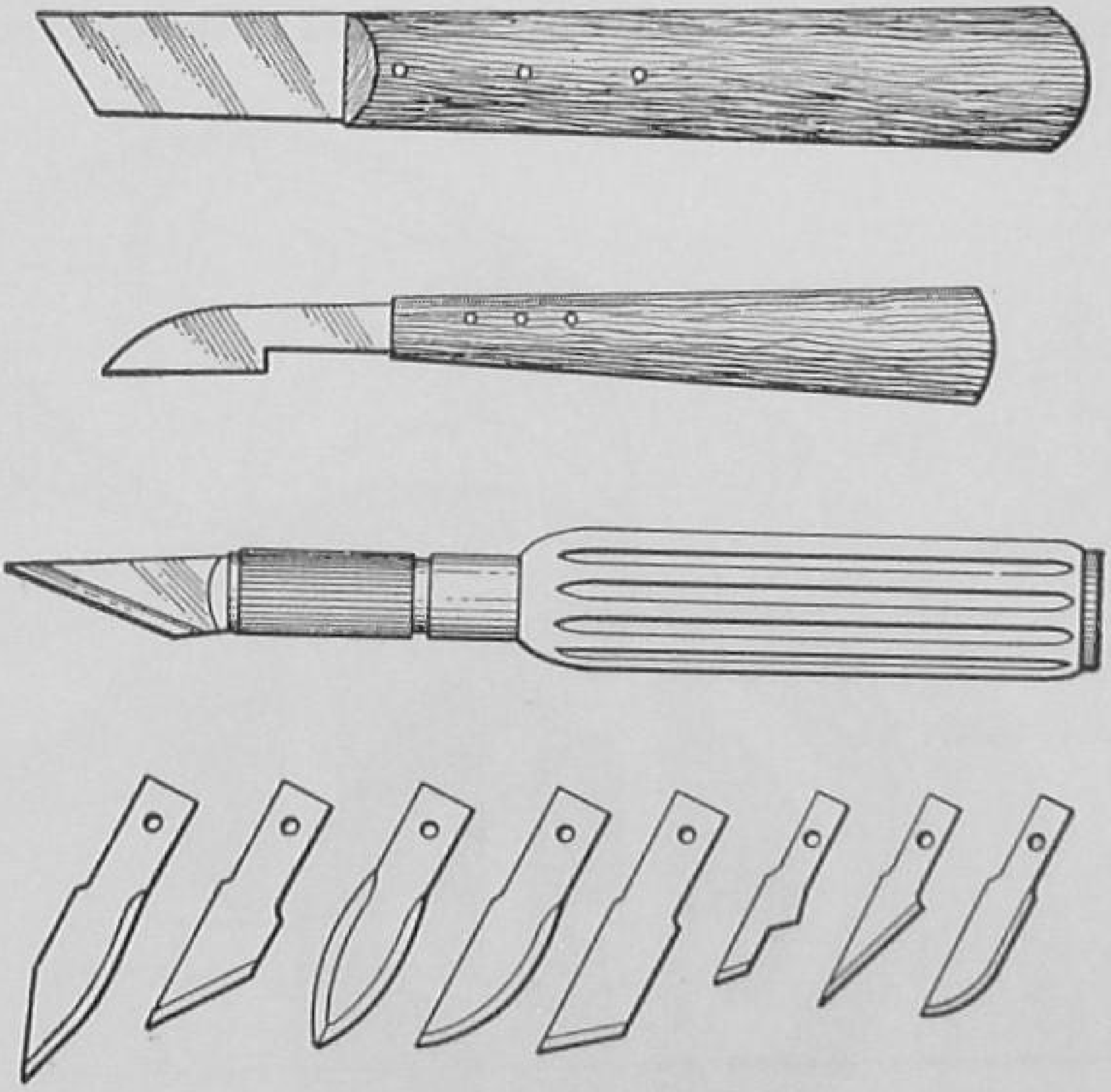


FIG. 186. Chip carving knives.

Chip carving is well adapted to the decoration of such projects as small boxes, shown in Chapter III, picture frames, etc. Geometric patterns, as illustrated in Fig. 187, are well adapted to chip carving; the triangle is used as a basic form and can be straight or curved and arranged in various interesting patterns.

The beginner should start with the triangle shown in Fig. 188:

1. Lay out the series of triangles as desired.
2. On each triangle, draw lines 1, 2, and 3 as shown in Fig. 188*A*.
3. Place the point of the chip carving knife at the point where lines 1, 2, and 3 meet. Press down hard on the knife at the beginning of the cut, draw the knife along lines 1, 2, and 3, decreasing the pressure on the knife as you work out toward each point of the diamond.

4. Now slant the knife and take a slicing cut toward the center of the triangle starting at point 4 section 1 of Fig. 188*B*. It will take several cuts to remove the entire section. Always cut so that the knife blade will be paring in the direction of the grain.

5. Repeat this process in section 2 as shown in Fig. 188*C* and in section 3, shown in Fig. 188*D*. The final cuts should leave the slanted sides of the triangle smooth.

The procedure is the same for the star figure and the rosette figure, which are both popular forms for chip carving.

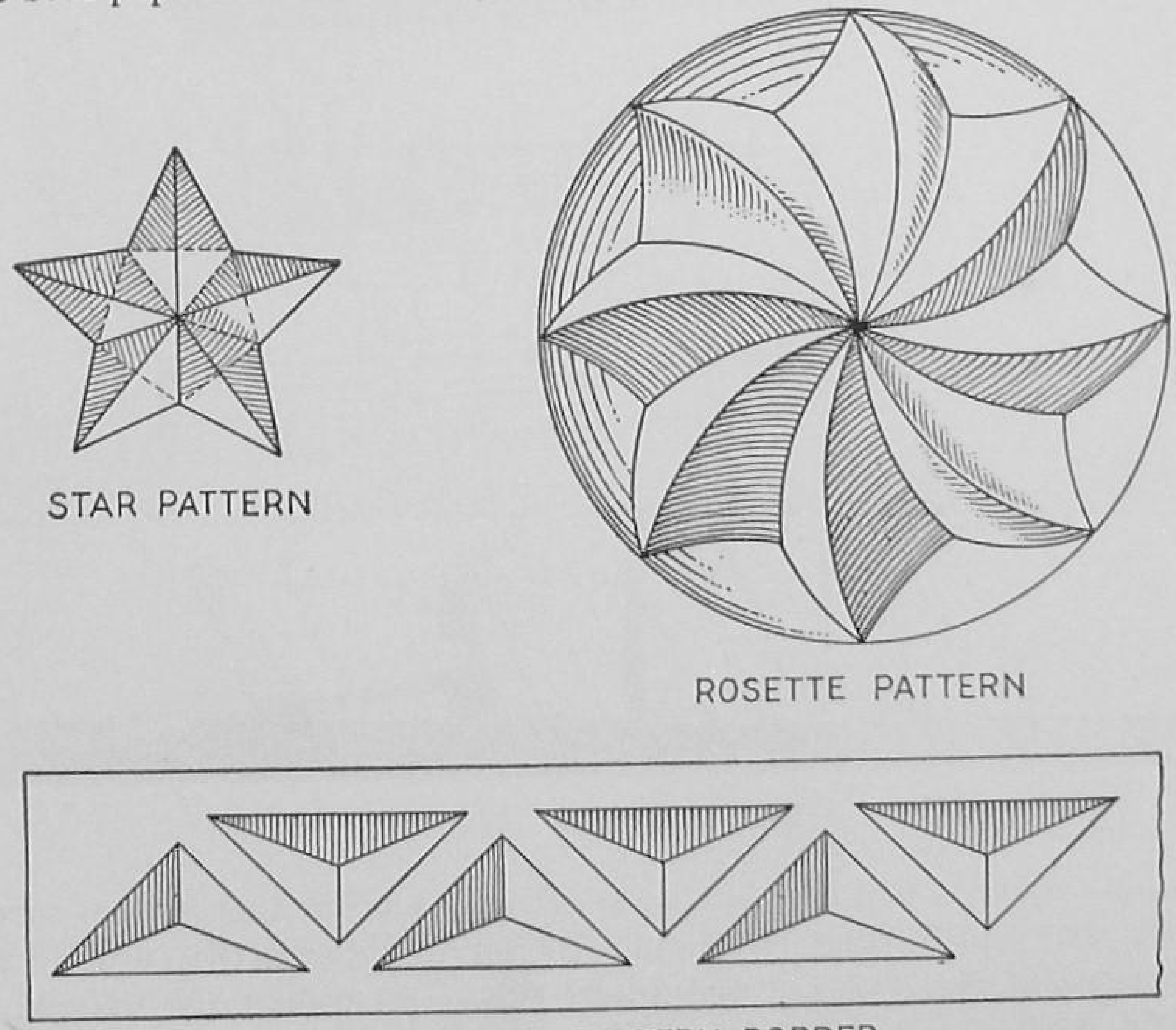


FIG. 187. Designs for chip carving.

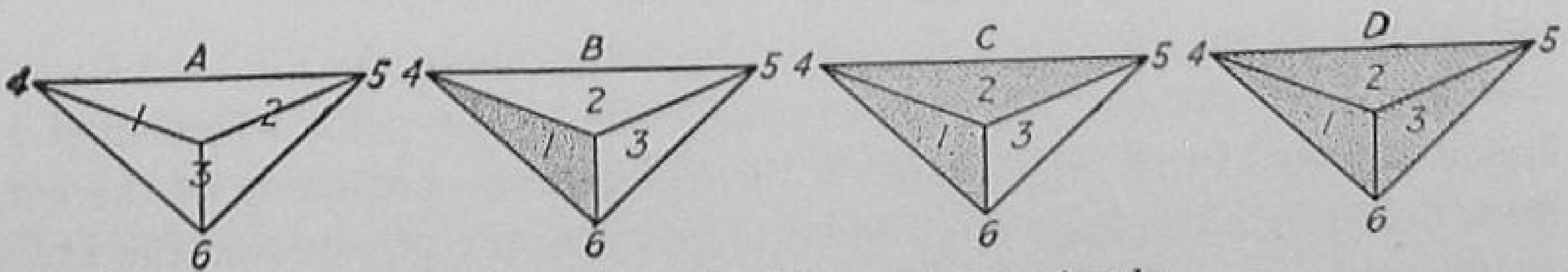


FIG. 188. Steps in chip carving a triangle.

III. Carving in Low Relief

A wood surface may be decorated by cutting away certain portions thereby bringing the design into relief. A few incised lines will accent certain portions of the design and the background may be left smooth or be stippled to provide various effects.

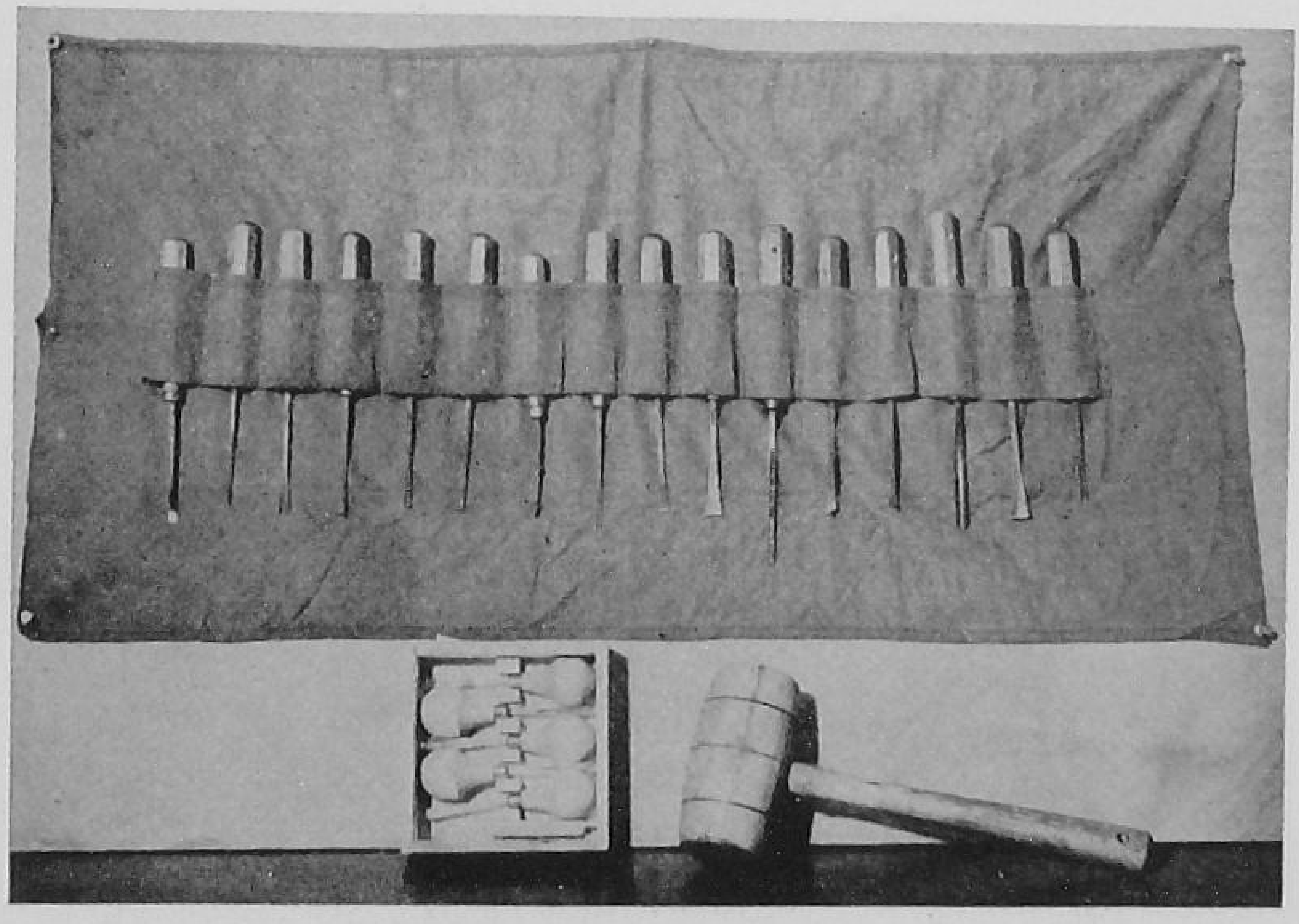


FIG. 189. Woodcarving tools.

This type of carving requires a greater variety of tools. Fig. 189 shows two sets of carving tools which are desirable. The small set in the box is the minimum and is obtainable at little cost. As a greater variety of work is attempted, the handicrafter should gradually acquire a greater variety of sizes and shapes of carving tools as shown in the canvas case. Fig. 190 illustrates the various shapes that are desirable and the sizes in which they can be purchased. It is not necessary to immediately obtain each of the sizes listed, but the carver will soon learn which of the sizes are most suitable to his use and can acquire those sizes as needed. The V-tool, or veiner, was described previously in this chapter and is one of the necessary shapes to obtain.

Sharpening of these tools is done similar to the manner of sharpening a plane iron. If the tool is badly nicked, it must first be ground to the

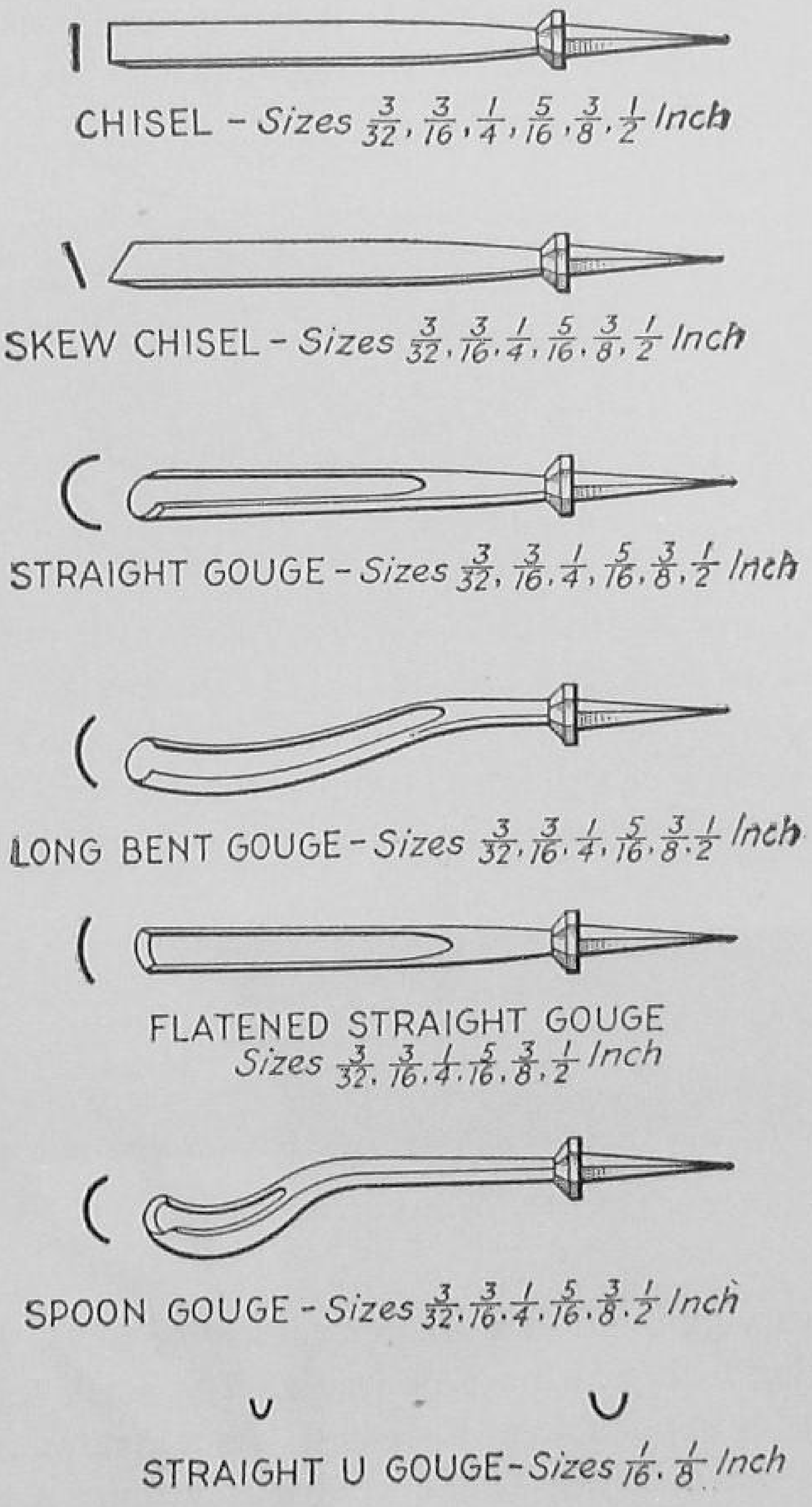


Fig. 190. Shapes and sizes of carving tools.

proper bevel on a grindstone, then whetted to a keen cutting edge on an oilstone. In order to remove the wire edge caused by grinding, small oilstones of various shapes are obtainable to fit the shape of the chisel being sharpened (Fig. 191).

A mallet is desirable where large areas of hardwood are to be removed. The mallet is used to strike the handle of the chisel, driving the cutting edge into the wood.

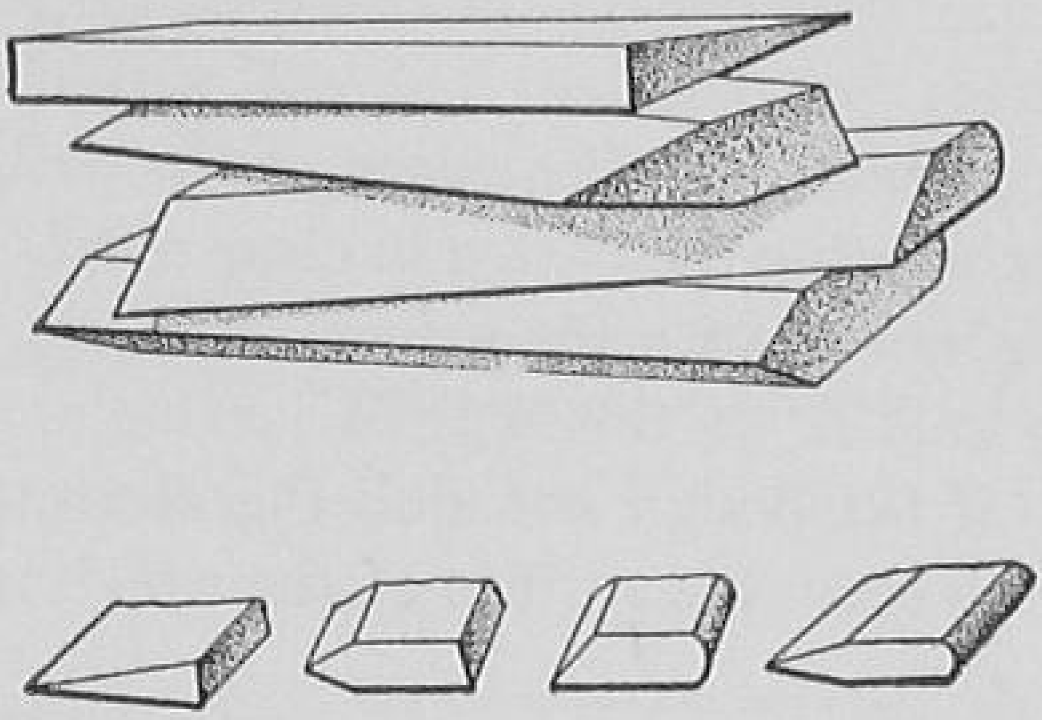


FIG. 191. Gilstones for sharpening tools.

A pair of book ends may be easily decorated with initials or a simple design as shown in Figs. 184 and 185. (1) The design is first drawn on paper and checked to see if it fits into the required space. (2) Trace the design on the surface of the wood, using carbon paper. (3) The outlines of the design are now "stop-cut" with a knife or chisel cutting to a depth

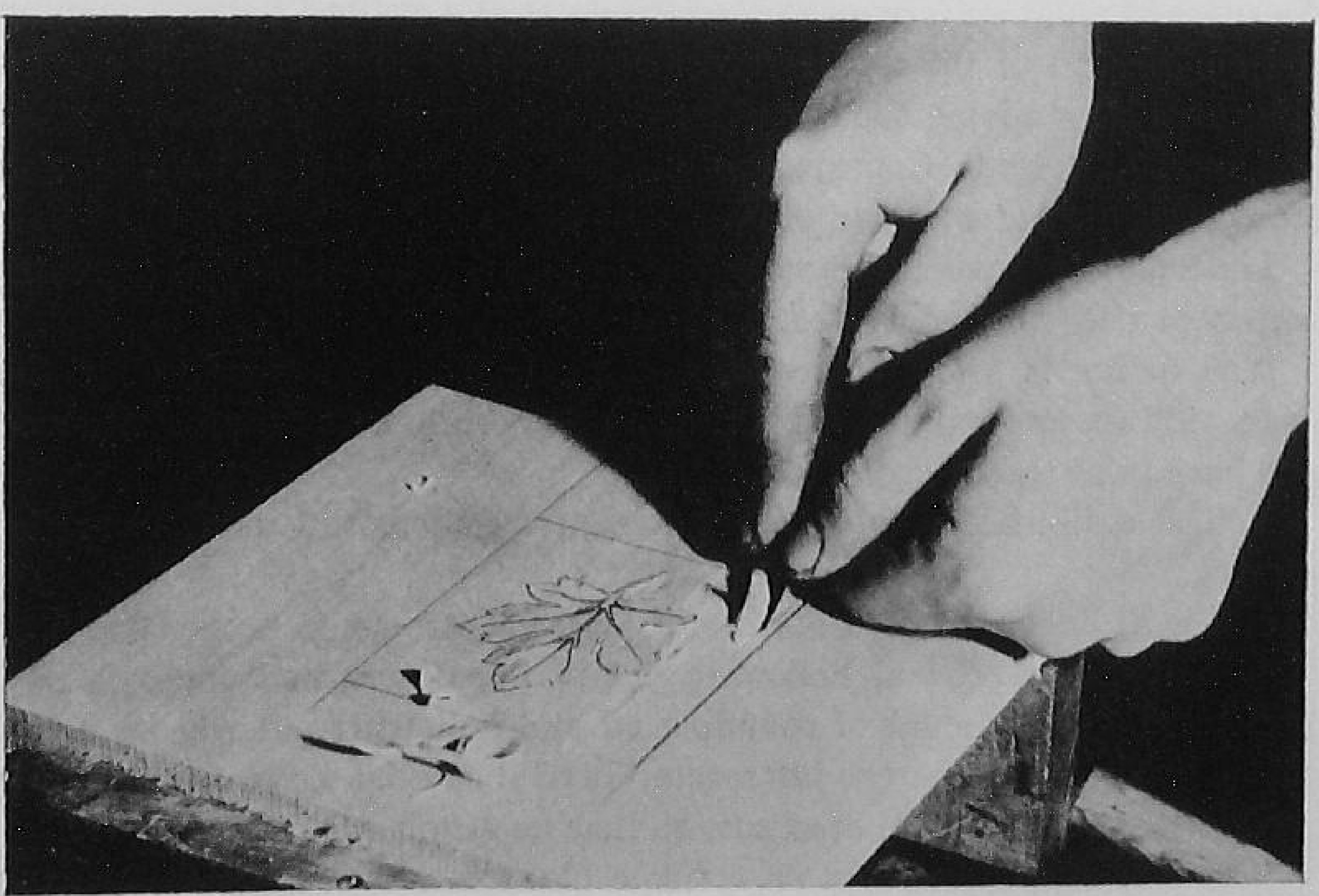


FIG. 192. Lowering the background with a gouge.

of about $\frac{1}{16}$″. (4) Using the various shaped chisels, begin to remove the wood around the design. A small gouge will remove the wood rapidly (Fig. 192) and the straight chisels and skew-shaped chisels are used to work up to the design outlines. These chisels are also used for smoothing the background if this is desired. Some designs look well with the rough gouge lines showing in the background. (5) The edges of the design are left perpendicular to the surface to bring the design in clear relief. Where desired, accenting lines are now incised with the veiner, or V-tool.

It is best to do no sanding on this type of carving as the sandpaper may round off the edges of the design and dull the clearcut relief desired. If sanding is necessary to clean the surface of the wood, rub lightly with 4/0 sandpaper.

The drawing of the book ends in Chapter III provides a nice project for decorating with low relief.

IV. Bas-Relief, or High-Relief Carving

In order to provide a more interesting decoration than the flat or low-relief carving, a rounding off, or sloping, of the sharp edges provides a more graceful and realistic carving. It consists not merely of rounding off the edges of a flat surface, or the scooping out of a hollow, but is a shaping and modulation of the design to produce an artistic effect. This can be illustrated by studying the curvatures of a leaf or petal of a flower or the roundness of a fruit. Consideration is given to the lights and shadows in facial expression of a human or an animal figure.

The tools used may be the same as for low-relief carving except a greater variety of sizes may be needed.

1. A design is first transferred to the surface of the wood. Only the main outlines are traced at this time as the detail lines may be removed and have to be traced again.

2. The outlines are cut and the background removed as in low-relief carving.

3. Detail lines are now traced on the design and cut to proper depth.

4. A rounding off and hollowing out of curvatures and edges is now performed. The amount of rounding off and hollowing out will be determined by the handicrafter's interpretation of the design he is carving. It is well to strive for smooth, even cuts so that no sanding is necessary.

The four steps illustrated on a single block of wood shown in Fig. 193 indicate the procedure for carving a simple rosette.

Fig. 194*A*, *B* and *C* illustrate the same operations being performed in the carving of a wall placque. Fig. 194*A* shows the operation of cutting away the background; Fig. 194*B* shows a method of cutting in the detail of a

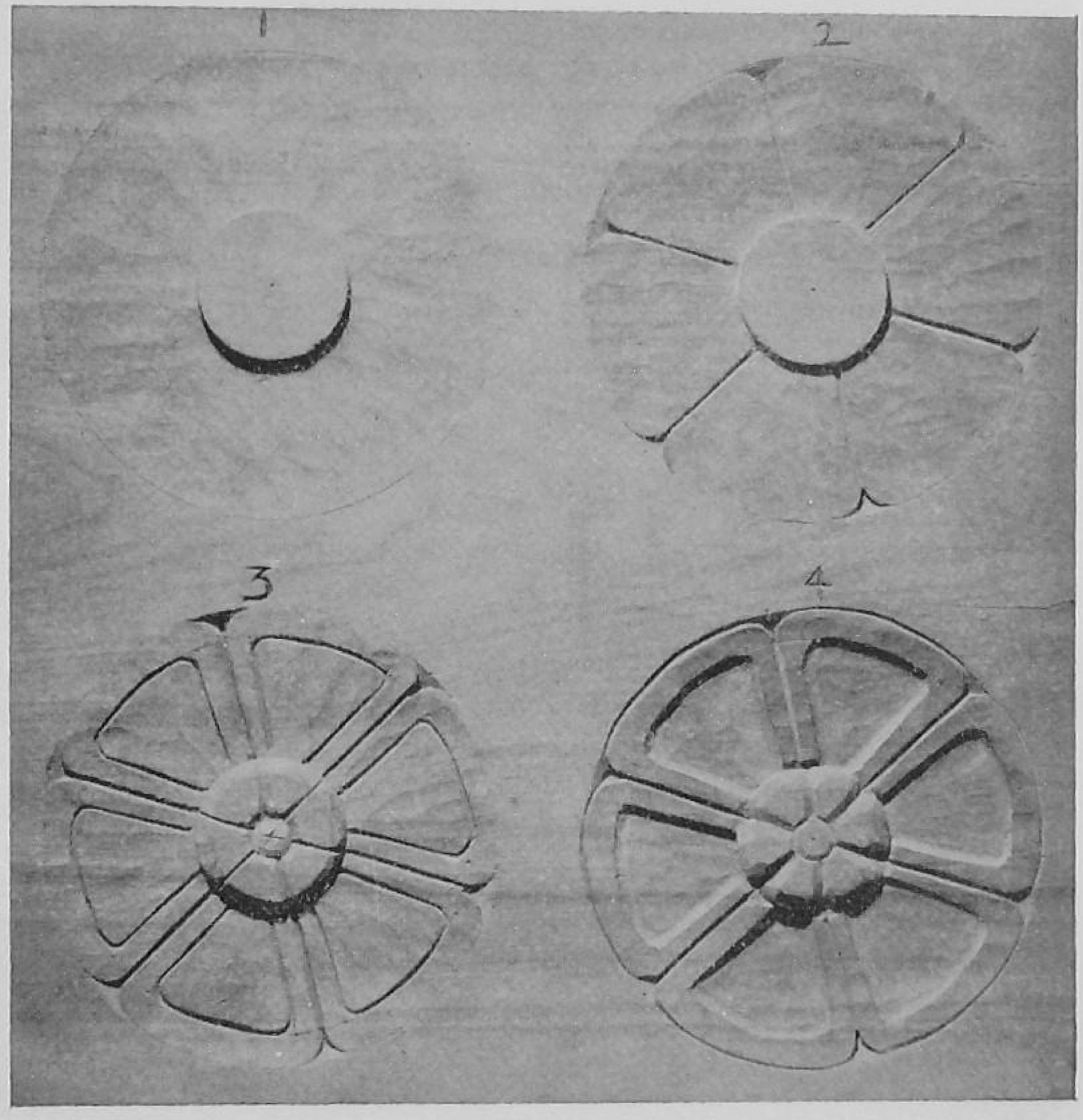


Fig. 193. Steps in carving a rosette in relief.

petal; and Fig. 194*C* shows the hollowing out and rounding off of a petal.

Figs. 195 to 198 show applications of several types of carving and of different designs. Fig. 195 shows a bas-relief carving with a few detail lines and a slight rounding off of edges, with a stippled background. Fig. 196 shows a figure in bas-relief on the same type of book ends. Fig. 197 shows

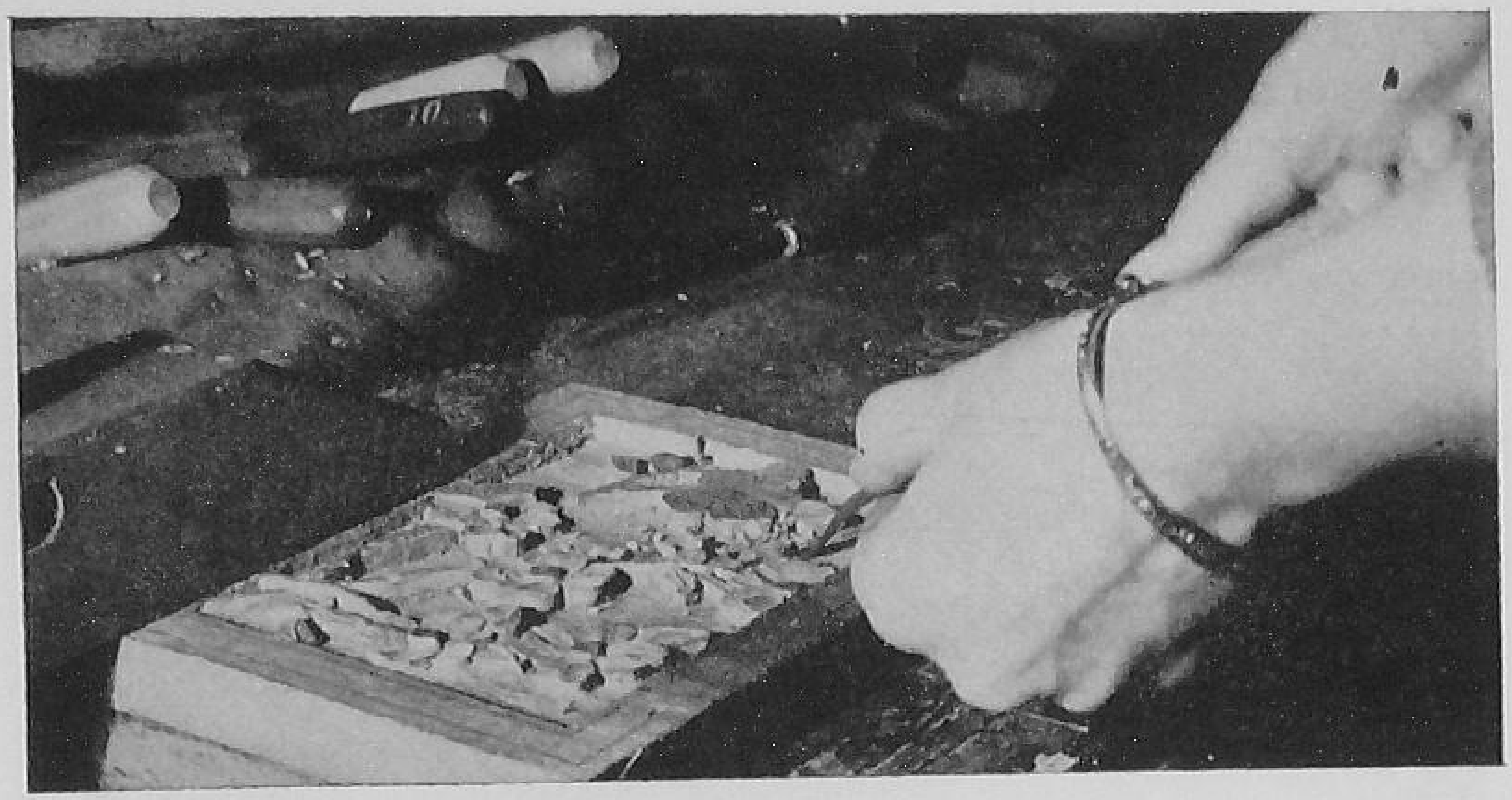


Fig. 194A. Scooping out background.

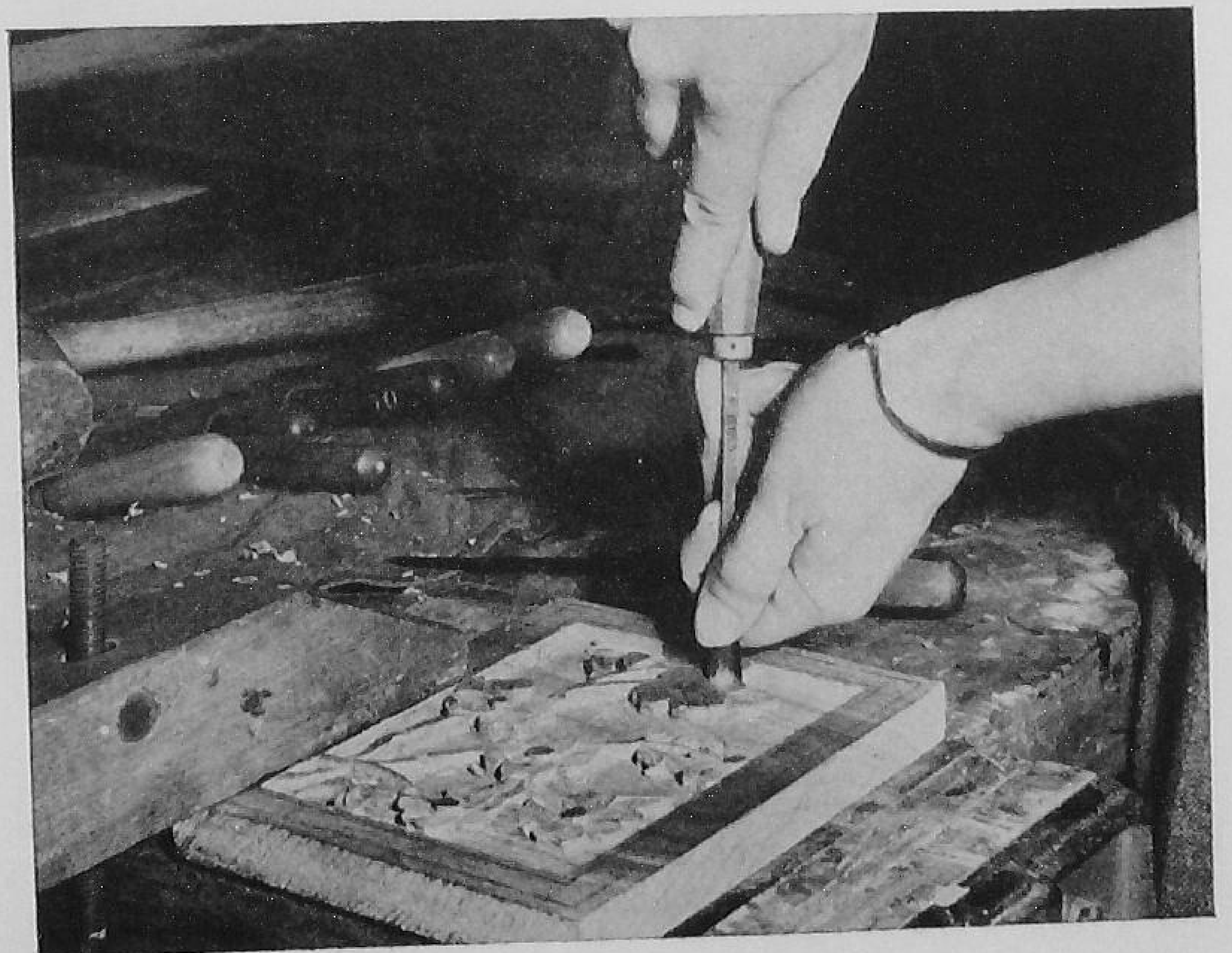


Fig. 194B. Cutting details.

the treatment of a flower design where a hollowing out of the petals is used rather than lines for the detail. Fig. 198 shows the application of a simple design in bas-relief to the surface of a tray. The surface is covered with glass.

FIG. 194C. Hollowing out and rounding design.

For practicing incised carving, chip carving, and low-relief carving, the handicrafter might make a set of coasters to place under drinking glasses. Cut a number of pieces of ¼″ thick basswood or pine, 3 inches square. On each of these, trace a design and proceed with the carving as explained. Each coaster may have a different design or the series may be the same. This project will provide practice in the use of the tools without using much wood or requiring much preparation of a surface to be decorated, at the same time a useful article will be produced.

Gouges. A gouge is a chisel with a curved blade. The parts of the gouge and the types of gouges are the same as those of chisels. The use of the gouge is similar to that of the chisel except that it is used for making con-

cave cuts. The bevel may be ground either inside or outside. Gouges are made with different amounts of curvature in the blades and are selected on the basis of fitting the job to be done. Gouges are sharpened in the same manner as chisels except that the burr or wire edge which is formed when

Fig. 195. Bas-relief carving with few detail lines.

the bevel is ground must be removed by whetting with a slipstone. Place the gouge on the bench, squirt several drops of oil in the curved blade and rub the slipstone back and forth until the burr, or wire edge is removed (Fig. 199). Be sure and hold the slipstone flat on the surface of the gouge.

FIG. 196. Bas-relief of a figure.

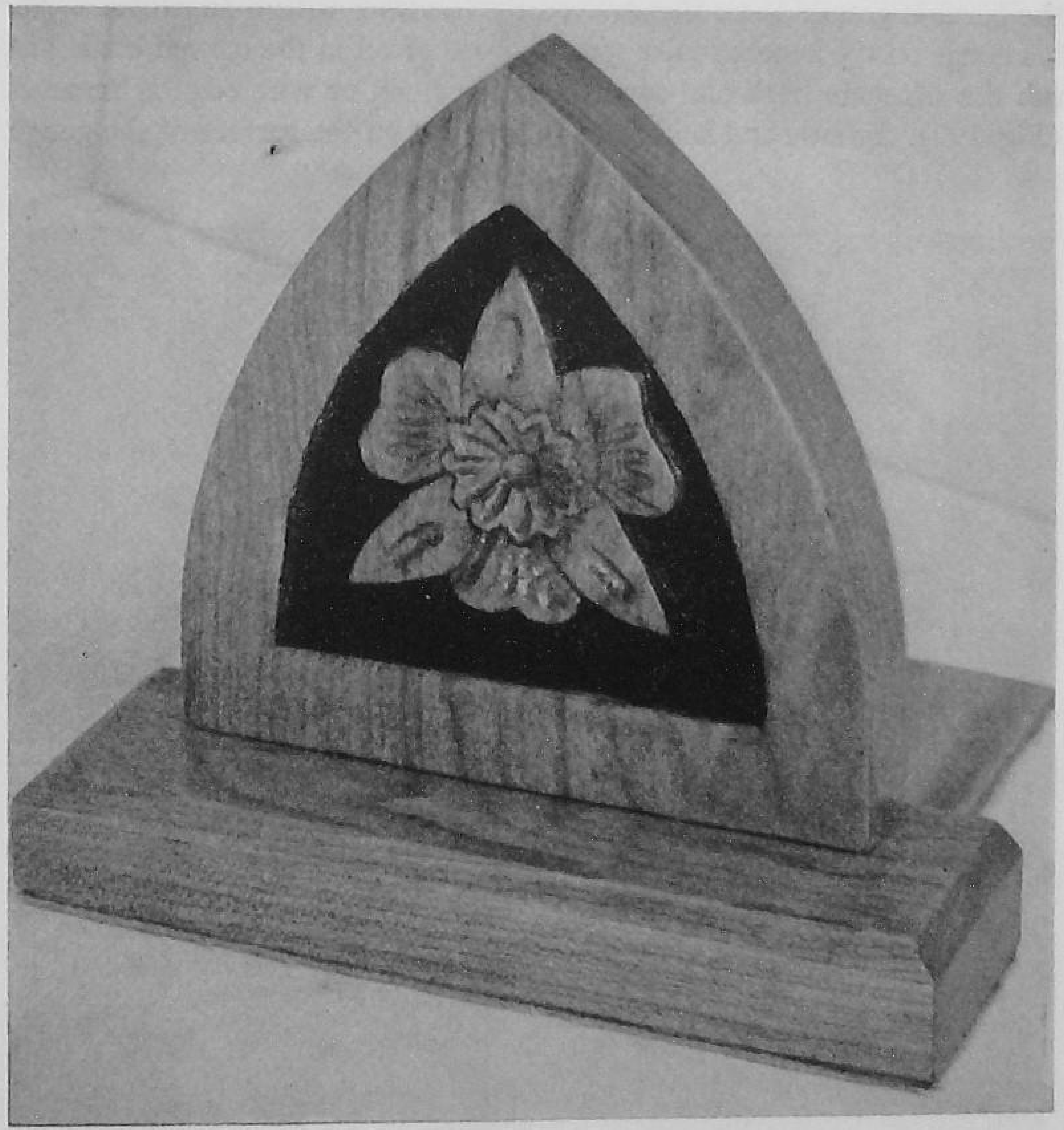


FIG. 197. Petals are hollowed out.

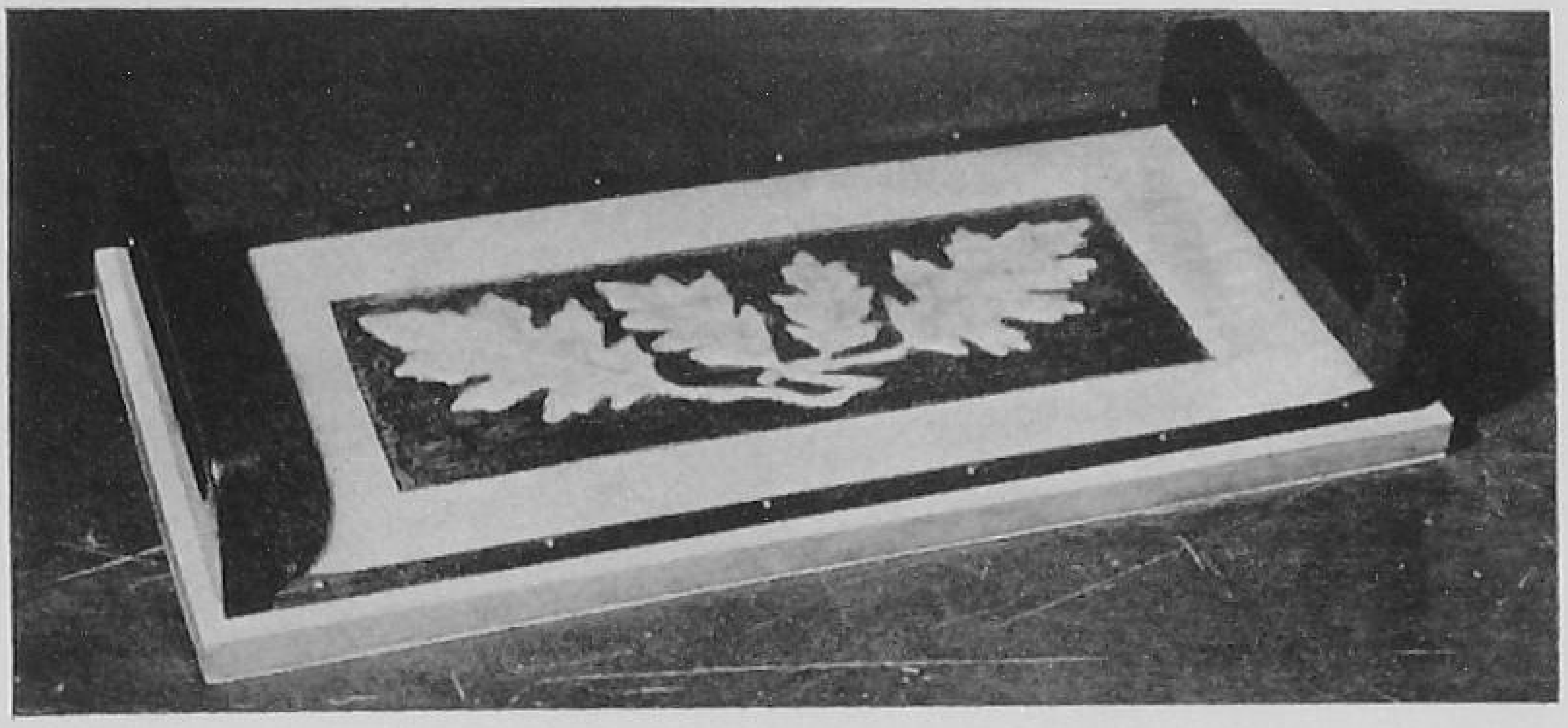


Fig. 198. Bas-relief on a tray.

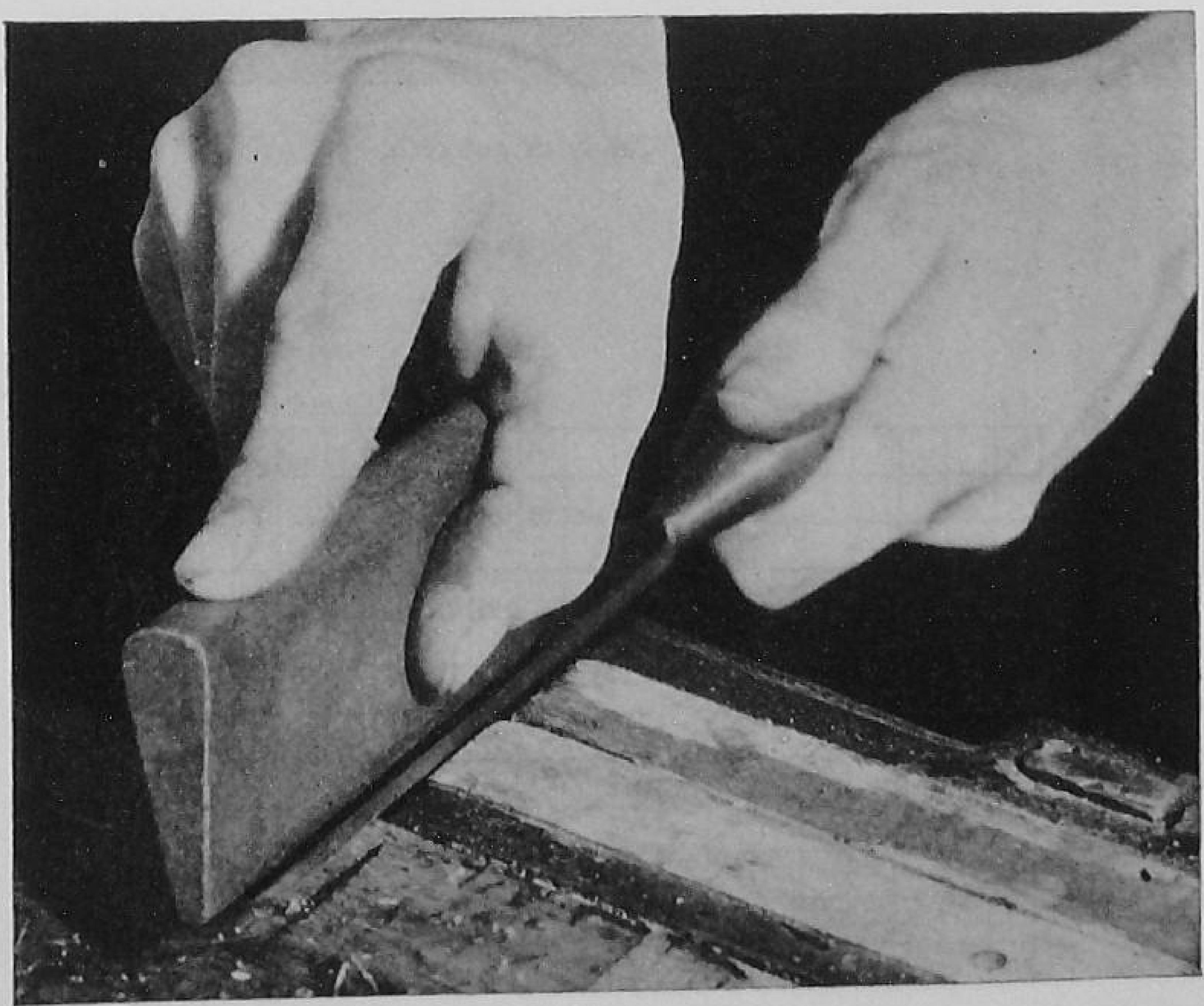


Fig. 199. Whetting a gouge with a slipstone.

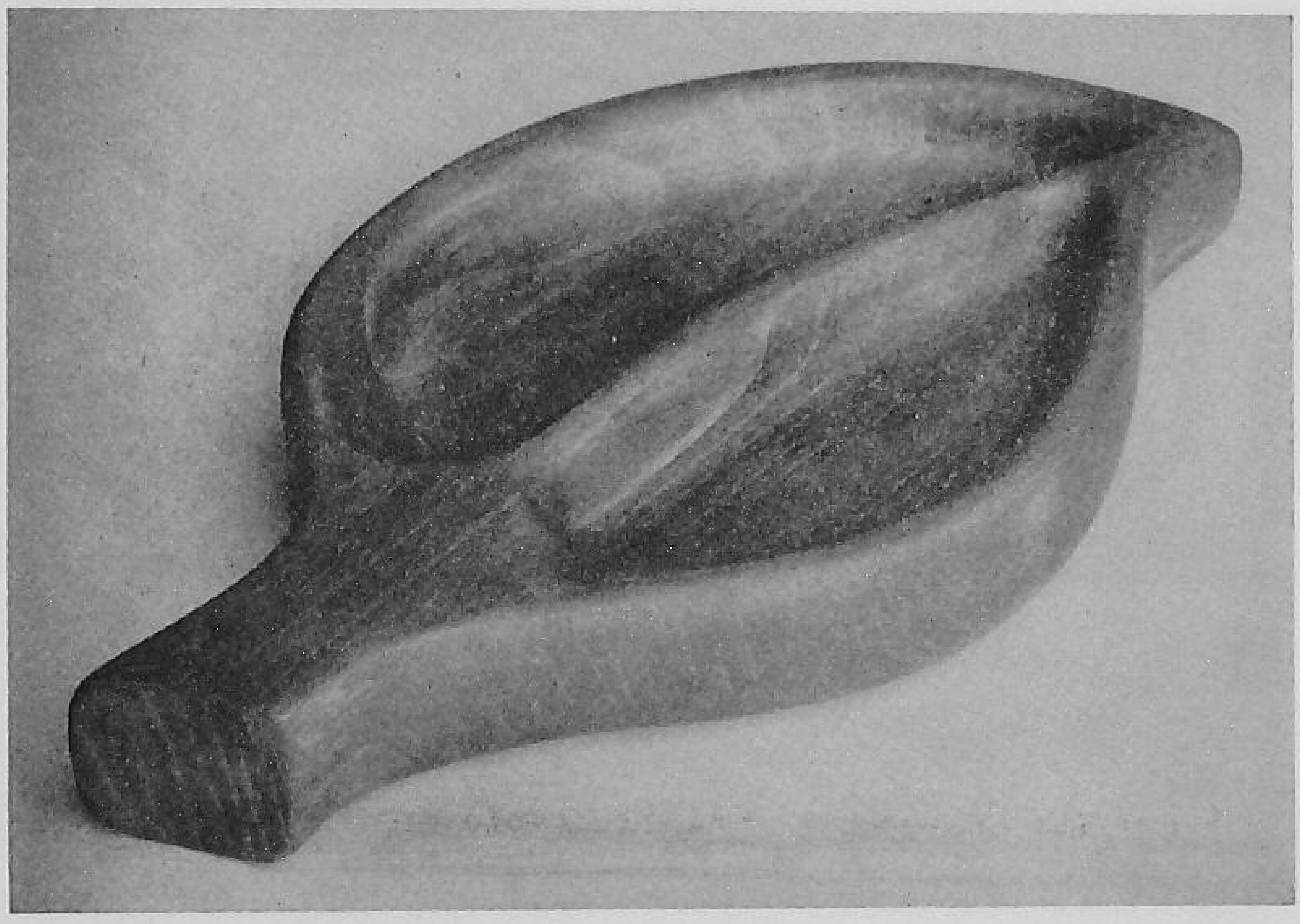


FIG. 200. Candy or nut dish.

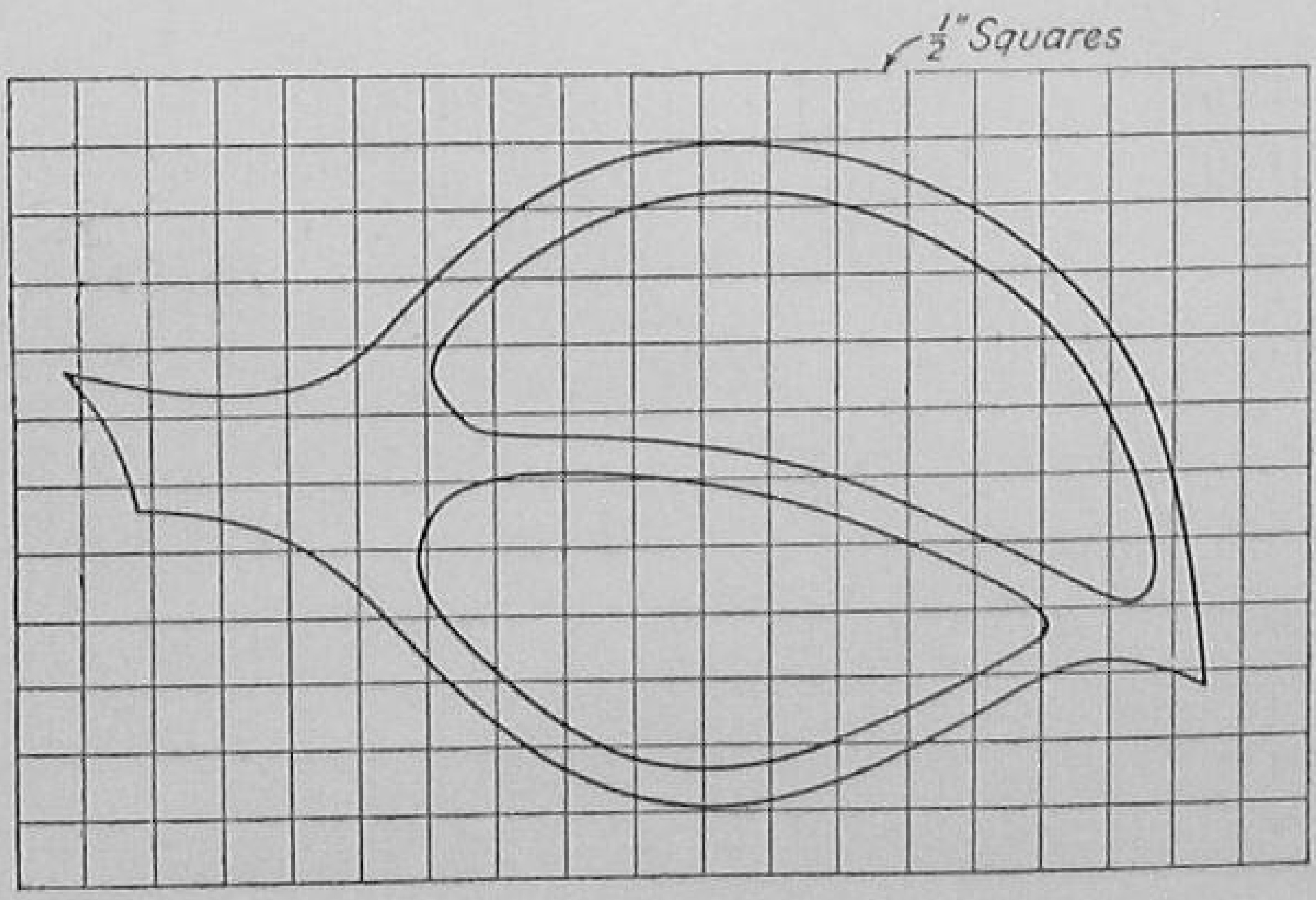


FIG. 201. Pattern of nut or candy dish.

Nut or Candy Dish

Practice in the use of a gouge to determine the action of the tool on the grain of wood can be acquired by making a nut dish as shown in Fig. 200. The worker can easily design a suitable nut or candy dish and proceed as follows:

1. Make a full-size drawing of the design shown in Fig. 201, or make your own design.

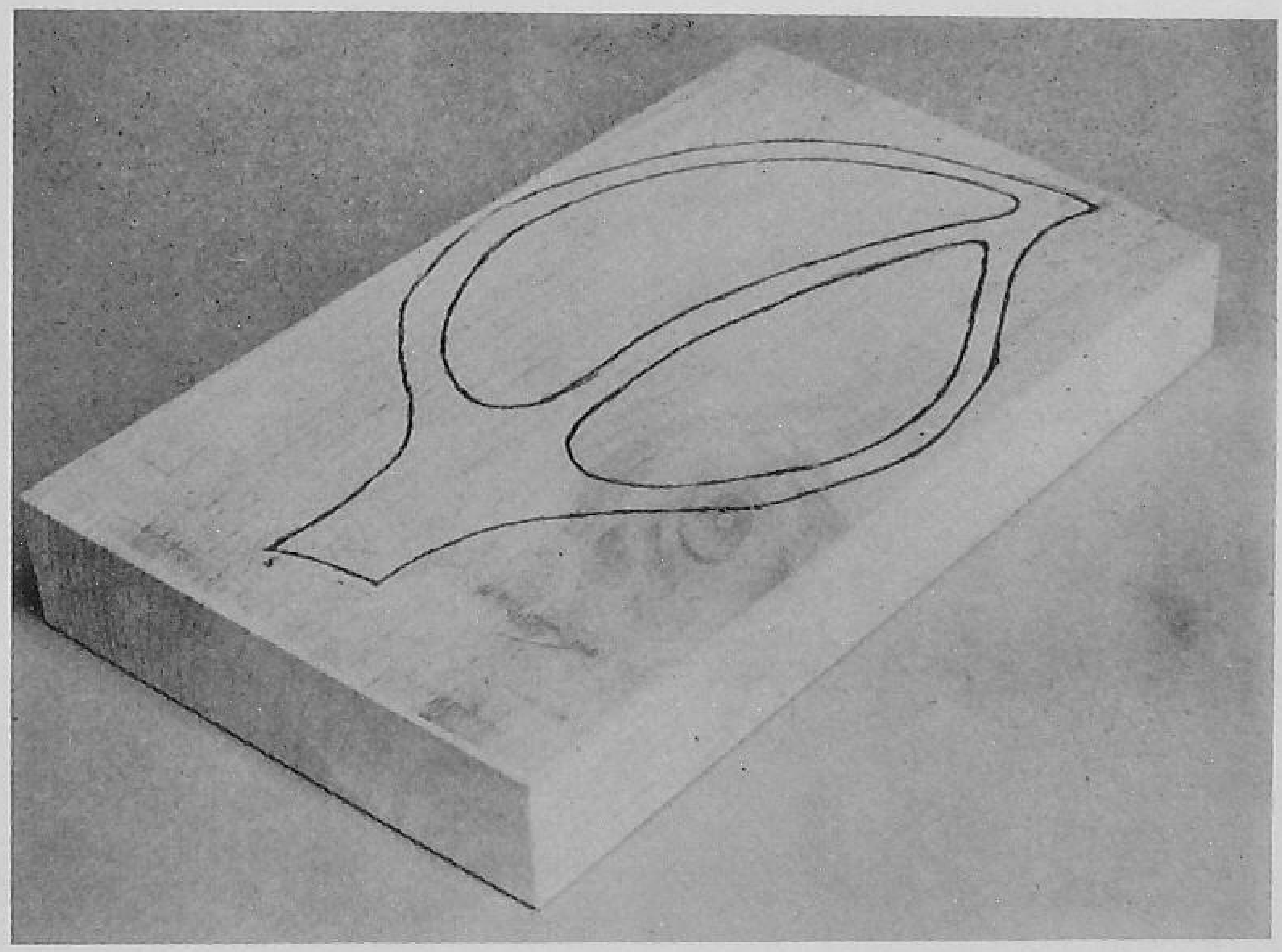


FIG. 202. Design transferred with carbon paper.

2. Obtain a piece of wood 1¼″ thick, 6″ wide and 9″ long. Both surfaces should be smooth and flat. Mahogany is a nice wood to use for this type of project, but the one described here was made of white pine.

3. Transfer the design to the surface of the wood by use of carbon paper (Fig. 202).

4. With a knife, score the lines of the portions to be hollowed out.

5. Clamp the wood securely to the bench and proceed to hollow out the

recesses (Fig. 203) using a 1-inch gouge. Work with the grain to prevent tearing the wood. Keep both hands on the gouge while paring, or if hardwood is used, one hand may hold the gouge and the other hand may hold a mallet for striking the gouge handle. Hollow both recesses to a depth of approximately 1″, rounding the edges with a gentle curve.

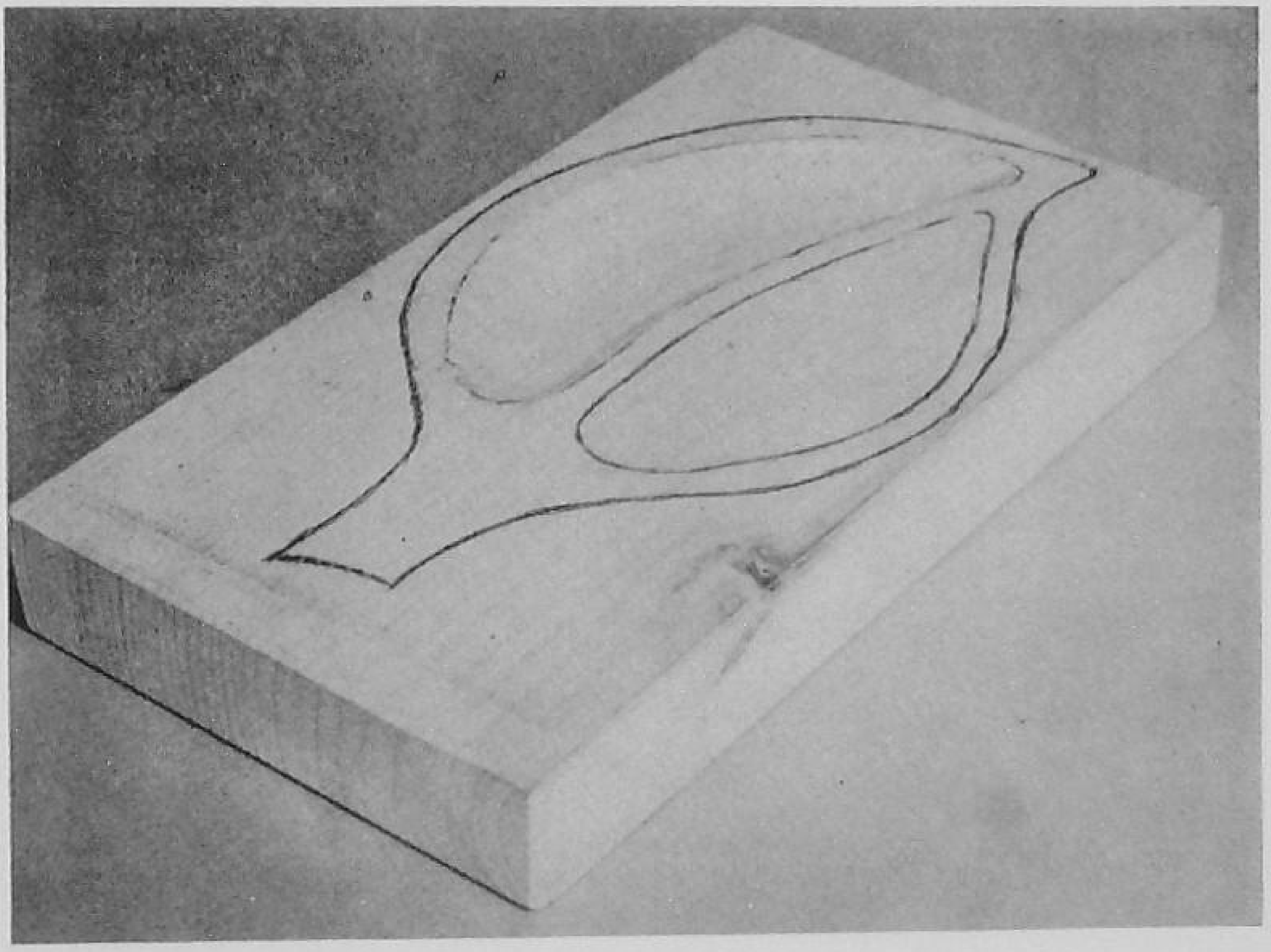


FIG. 203. Recessing the dish.

6. Smooth the recesses, using first No. 0 sandpaper, then No. 2/0 sandpaper (Fig. 204).

7. With a coping saw, cut the outside contours of the dish.

8. Smooth the edges with a woodworker's file and round off the bottom edge.

9. Sandpaper the entire project.

10. The dish is now ready for finishing and may be stained, shellacked or varnished as desired. If mahogany wood is used an interesting effect is obtained by leaving the recesses natural color and staining the remaining portion with a dark mahogany stain.

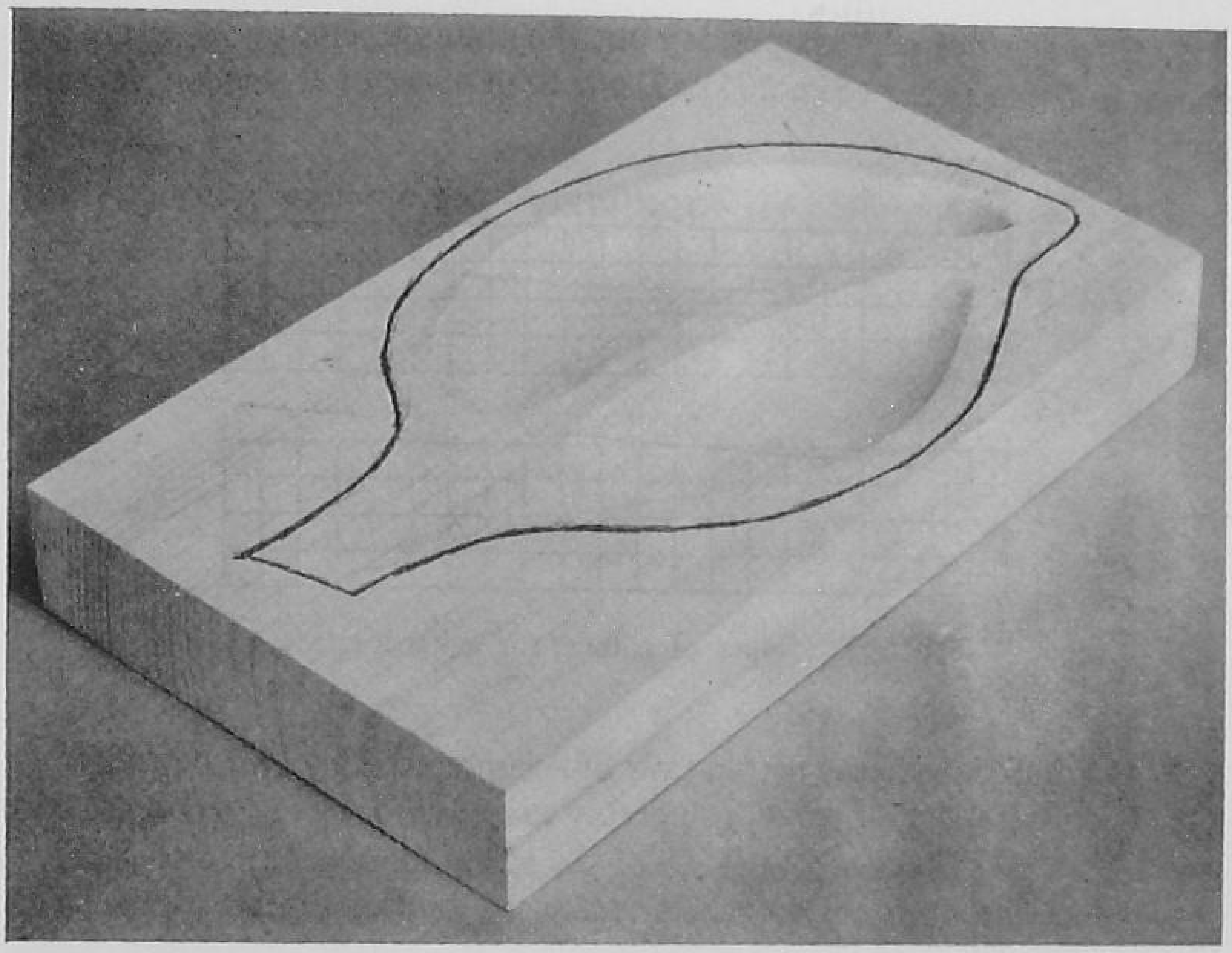


FIG. 204. Recesses sanded.

Wooden Spoon

The wooden spoon (Fig. 205) and fork set makes an interesting project for the practice of carving. The steps in making a spoon are described as follows:

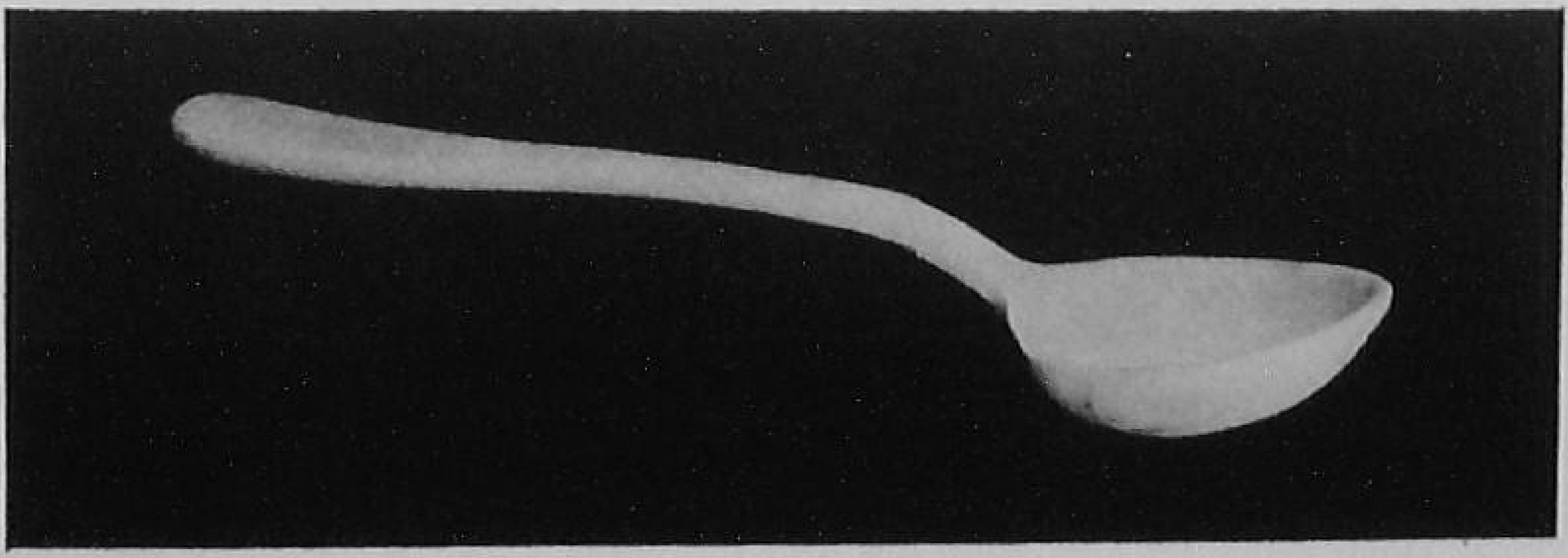


FIG. 205. Wooden spoon.

1. On a sheet of white paper, lay out the same number of ½″ squares as shown in the drawing (Fig. 206). Draw both views of the spoon, top view and side view.

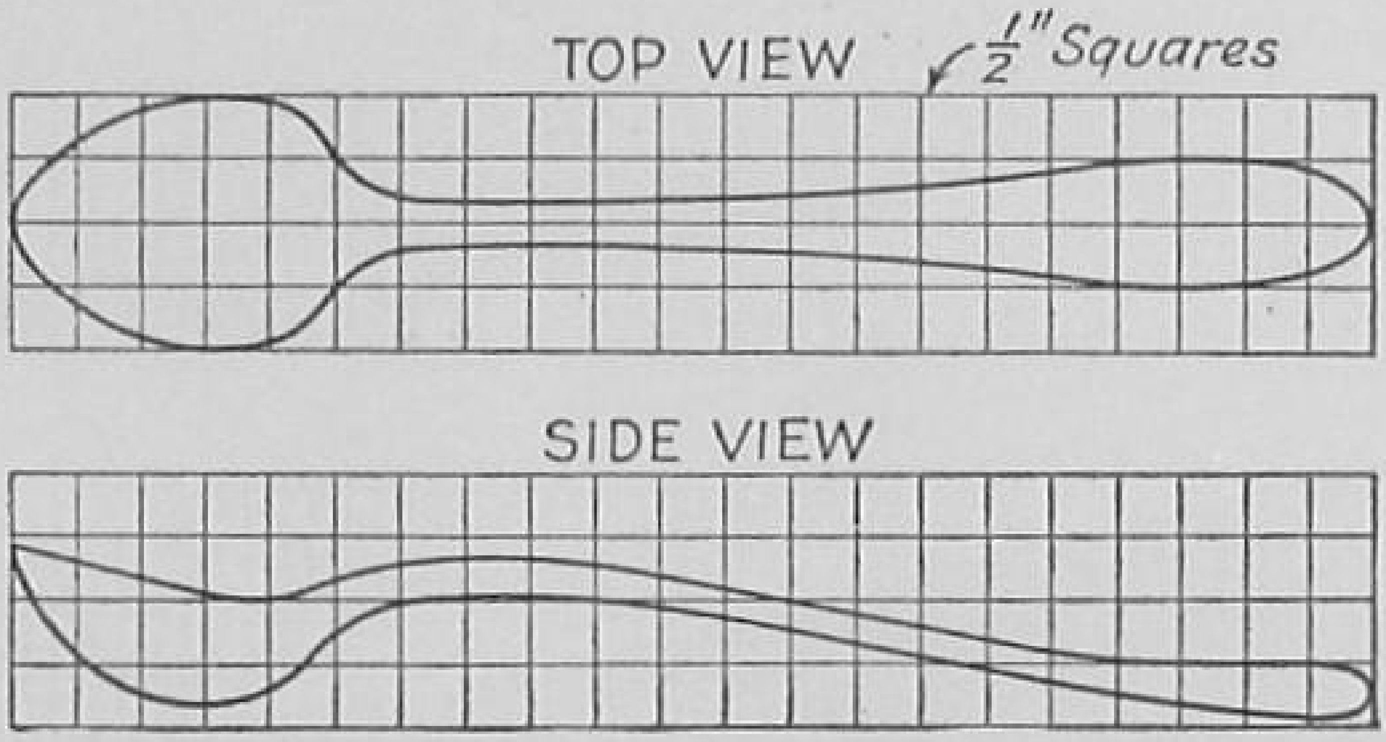


Fig. 206. Layout of pattern for wooden spoon.

2. Cut out the outline with a pair of scissors, making two patterns.

3. Obtain a block of wood, preferably maple or birch, 2″ thick, 2″ wide, and 11″ long. (The size and shape of the spoon may be varied to suit.)

4. Using the patterns as guides, draw the outline of the spoon on the block of wood (Fig. 207).

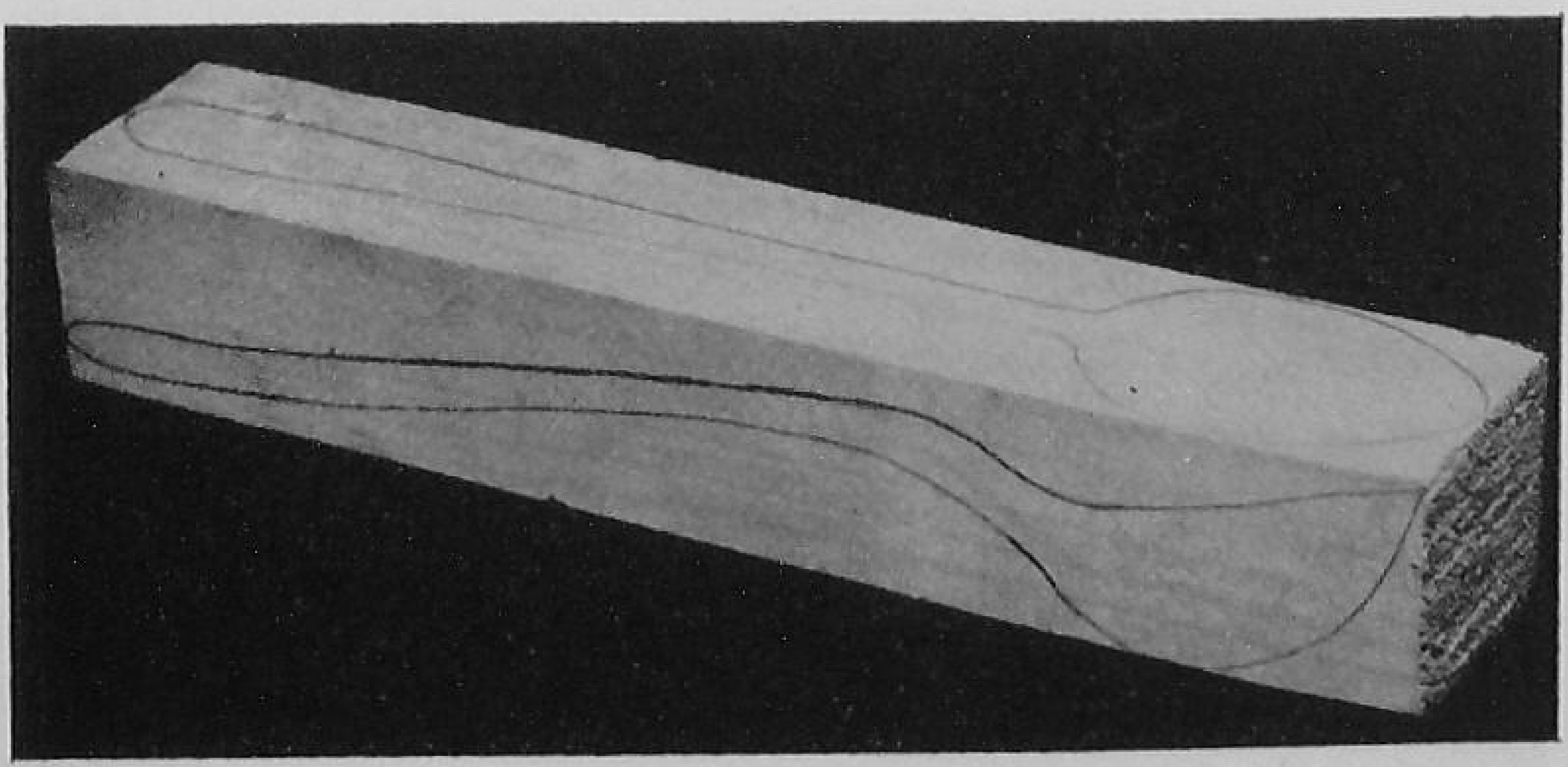


Fig. 207. Outlines drawn on block.

5. With a coping saw, saw out the top view (Fig. 208). The pieces of waste wood may be nailed back on with small brads for easier clamping in

the vise, or the side view pattern may be placed on the sides of the spoon and the lines redrawn.

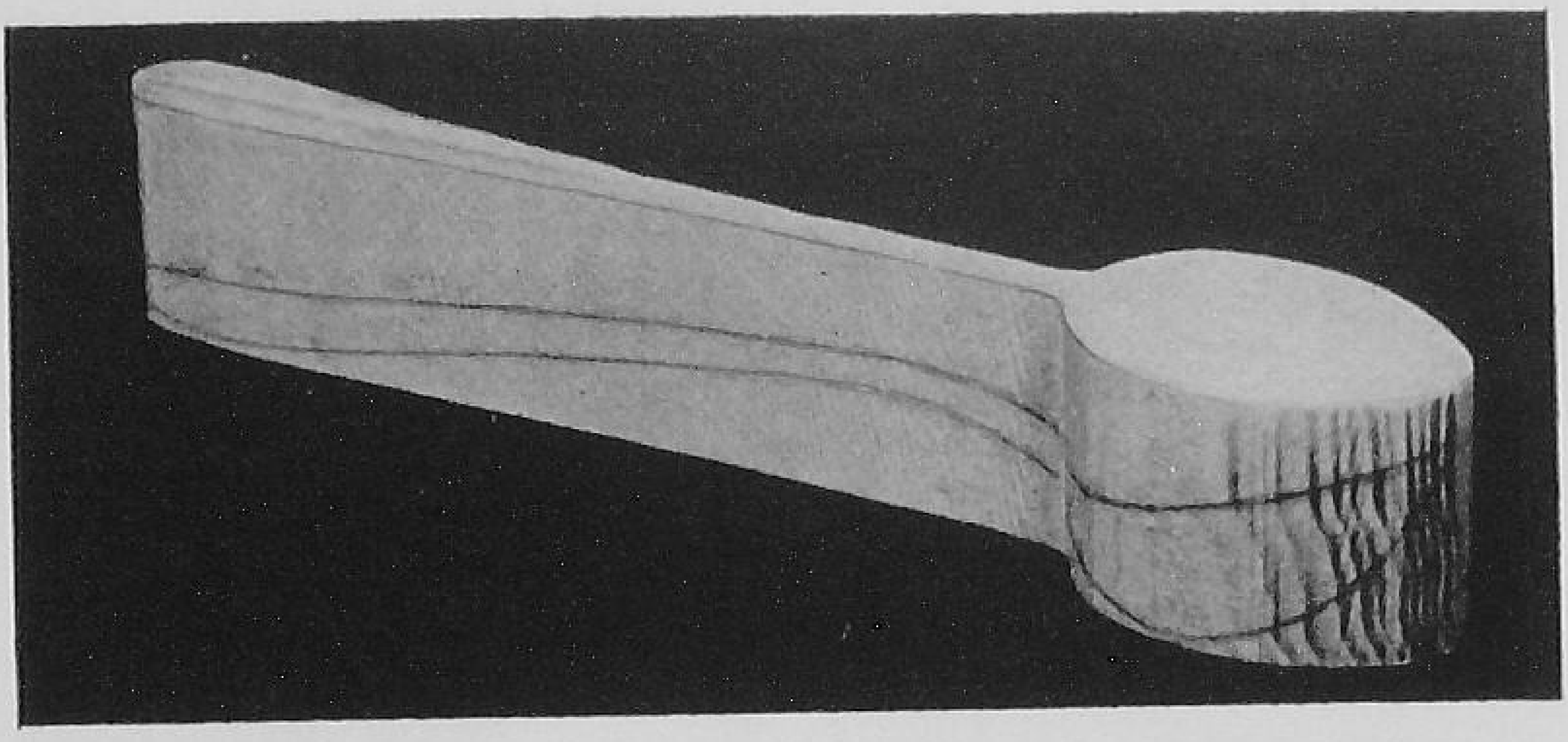


FIG. 208. Sides cut off.

6. With a coping saw, saw the top and the bottom of the spoon (Fig. 209).

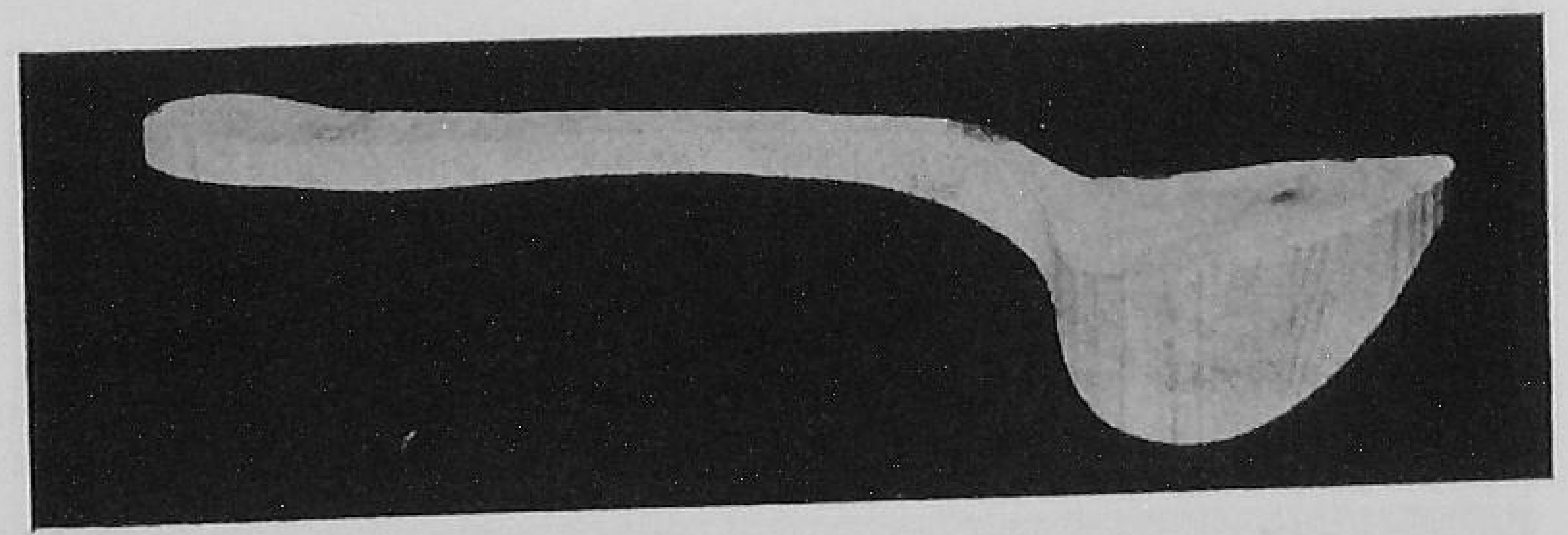


FIG. 209. Top and bottom sawed out.

7. Clamp the spoon in a vise and using a ½″ gouge, hollow out the spoon (Fig. 210).

8. With a chisel or a woodworker's file, shape the outside of the spoon (Fig. 211).

9. Sand the entire spoon with No. 0 sandpaper, then with No. 2/0 sandpaper.

10. Finish by applying one coat of shellac, rub with fine steel wool when the shellac is dry, then apply a coat of clear lacquer.

The fork is made in the same manner but requires less usage of carving tools. A design may be carved on the handles, using any of the types of

FIG. 210. Hollowing out the spoon.

FIG. 211. Shaping the outside of the spoon.

carving already described. The shape and size of the spoon and fork may be determined by the handicrafter to suit his individual desires.

Fig. *212* illustrates a more advanced type of carving project that may be attempted by the handicraft worker after he has acquired basic skills while making the projects and designs just described.

Fig. 212. Suggested project for carving.

Metal Art Crafts Section

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INTRODUCTION TO METAL ART CRAFTS SECTION

Metal Art Crafts is a section of materials, tools, processes, and projects designed for the use of those who are interested in exploring the various areas of metalcraft. Each individual material used in the craft shop is described in detail including such pertinent information as it is necessary to know when selecting and ordering the materials needed. All the tools common to metalcraft work are illustrated and supplemented with an explanation and description of the particular function of each. The object of this section is to acquaint the reader with the proper use and nomenclature of each hand and machine tool used in metalcraft work. The section on processes and operations has been organized in such a manner that the metal-worker can look up the directions for any particular phase of metalcraft in which he may be interested.

Seventeen projects have been grouped in the final chapter, each including a drawing and picture of the finished article, and, on the opposite page, a bill of material and the step-by-step procedure necessary for the construction of the project. Projects have been arranged in groups involving the various phases of metalcraft work. For this reason, the beginner need not necessarily start with project number one. It is suggested, however, that the beginner select a basic project before attempting one which may be too difficult. Before any project in Chapter IV is attempted, reference should be made to the more detailed description of the materials, tools, and processes as described in the previous chapters.

III. METAL ART CRAFTS SECTION

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Chapter I

METALCRAFT MATERIALS AND SUPPLIES

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Chapter II

TOOLS USED IN THE METALCRAFTS

•

Chapter III

OPERATIONS AND PROCESSES IN METALCRAFT

•

PROJECTS

1—Galley Ship Plaque
2—Bracelet
3—Coaster
4—Miniature Scuttle Ash Tray
5—Cigarette Tray
6—Wall Pocket
7—Candlesticks
8—Copper Plant Box
9—Leaf Tray
10—Ash Tray
11—Candy Dish
12—Fluted Bowl
13—Button Box
14—House Bank
15—Chasing Tools
16—Plant Stand
17—Pin-Up Lamp

Chapter I

METALCRAFT MATERIALS AND SUPPLIES

Copper.

Copper is the most common metal used in the metalcraft shop. Since it is soft, very ductile, and malleable, it can be used for work which requires stretching by hammering and bending. Copper has a reddish color, will take a fine polish, and reacts when treated with various chemicals, producing various colored effects on its surface.

The most common form in which copper is used in the metalcraft shop is in sheets. It may also be obtained in the form of rods, bars, tubes, and wire. A sheet measuring 30″ x 60″ is a common size and is recommended for a shop which is equipped with a 30″ squaring shear. Some supply houses furnish copper in coils 12″ or 18″ wide. These sizes are more easily handled when no squaring shear is available.

The thickness of copper is gaged by the Brown & Sharpe gage. This is a system of gage numbers, each indicating a definite thickness in thousandths of an inch. The B & S gage numbers range from Nos. 0000 to 40. The larger the gage number the less the thickness of the metal. A No. 14 gage sheet is about 1/16″ thick. When ordering copper it is well to specify the B & S gage number and the thickness of the sheet in thousandths of an inch in order to eliminate errors in the use of other than B & S standard gages. The price of copper sheets is figured by the pound. It is therefore necessary to know the weight of the sheet when ordering so that the net price can be determined. The following table is useful in checking the gage and weight of sheet steel, iron, brass, and copper.

Sheet copper is frequently designated by the weight in ounces per square foot instead of the B & S gage number. The use of this system eliminates the necessity of measuring and weighing the copper. The practice of using various gages to measure sheet metals makes it imperative to designate the gage being used or the thickness in thousandths.

The most suitable sheet copper for use in metalcraft work is *cold-rolled, annealed.* Cold-rolled sheets have a bright smooth surface and are not likely to be pitted or contain deep scratches. Annealed stock is soft

Comparative thickness of copper sold by weight showing nearest B & S and Stubs gage number

Weight per Sq. Ft. (Ounces)	Weight per Sq. Ft. (Pounds)	Thickness (Inches)	Nearest Gage Number B & S	Nearest Gage Number Stubs	Nearest Fraction
	16	.3456	00	00	11/32
	15	.3240	0	0	21/64
	14	.3024	1	1	19/64
	13	.2808	1	2	9/32
	12	.2592	2	3	1/4
	11	.2376	3	4	15/64
	10	.2160	4	5	7/32
	9½	.2052	4	6	13/64
	9	.1944	4	6	
	8½	.1836	5	7	3/16
	8	.1728	5	8	11/64
	7½	.1620	6	8	
	7	.1512	7	9	5/32
	6½	.1404	7	10	9/64
	6	.1296	8	10	1/8
	5½	.1188	9	11	
80	5	.1080	10	12	7/64
72	4½	.0972	10	13	3/32
64	4	.0864	11	14	
56	3½	.0756	13	15	5/64
48	3	.0648	14	16	1/16
44	2¾	.0594	15	17	
40	2½	.0540	15	17	
36	2¼	.0486	16	18	3/64
32	2	.0432	17	19	
28	1¾	.0378	19	20	
24	1½	.0324	20	21	1/32
20	1¼	.0270	21	22	
18	1⅛	.0243	22	23	
16	1	.0216	23	24	
14	⅞	.0189	25	26	
12	¾	.0162	26	27	
10	⅝	.0135	27	29	
8	½	.0108	29	31	
6	⅜	.0081	32	33	
4	¼	.0054	35	35	
2	⅛	.0027			

and can be bent and formed into shape directly without the necessity of annealing before the work is started. Sheets should be protected in storage so that the surface does not become scored. Large sheets may be cut on the squaring shear to convenient sizes to fit on a shelf or bin. Coil stock may be stored on a shelf and cut from the coil as it is used.

Brass and Bronze.

Common brass is a copper-zinc alloy containing one-third zinc and two-thirds copper. Bronze is a copper-tin alloy containing 90 per cent copper and 10 per cent tin. Both tin and zinc are commonly used in the same alloy so that we have an almost infinite variety of copper-tin zinc alloys with varying percentages of each metal. All these bronzes contain at least 50 per cent copper.

Brass varies in color from a low brass, which contains a high percentage of copper (about 85 per cent) and has a reddish color, to a high brass, which has a high zinc content (about 35 per cent) and is much lighter in color. Brass is harder and not as malleable as copper and is therefore not as easy to work.

Bronze is usually more copper-colored than brass; however, this is not always the determining factor in identification. Bronze alloys are much harder and more brittle than brass and for this reason are of little use in the craft shop. Ornaments and *findings* are sometimes cast of bronze and may be purchased from a supply house for use as needed.

Common brass is obtainable in rods, bars, flats, tubes, wire, and sheets. Sheet brass is available in the same size sheets as copper. As with copper, the thickness of brass and bronze sheets is generally designated by the B & S gage number. Brass, finished by annealing, is designated thus:

Light anneal or blued
Drawing anneal or blued soft
Soft drawing or soft

Brass bar, rod, and strip is purchased by giving the dimensions of the particular shape required and the length. Brass wire is measured with the B & S gage and may be bought either by weight or by the length.

German Silver.

German silver, or *nickel silver* as it is sometimes called, is an alloy resembling silver. Its composition is generally 60 per cent copper, 20 per cent zinc, and 20 per cent nickel however, various alloys will contain more

or less nickel. German silver has much the same physical properties as brass and is sold in coils 6″ or 12″ wide. Like brass and copper, the most common thickness gage used to designate German silver is the B & S gage. When ordering, order either hard or annealed depending on the use to which the metal is to be put.

Zinc Based Alloys.

There are many alloys on the market which contain varying amounts of zinc, aluminum, copper, and tin. Alloys containing zinc as the major alloying element are known as zinc alloys. These alloys, like the copper alloys, are almost infinite in number. Zinc alloy sheets are sold for metal-craft work under various trade names. The color of zinc alloy resembles pewter and may be substituted for this metal in certain elementary work; however, its quality is inferior to pewter and therefore, if possible, it should not be used as a substitute. Zinc alloy, however, in the form of pigs weighing about five pounds, makes a good metal for melting and casting. Its melting temperature is about 800° F. and therefore can be easily melted in a three-burner gas furnace. It takes a high polish but will tarnish quickly if its surface is not lacquered.

Aluminum.

In the past century, the process of refining aluminum has been so rapidly developed that the price has gradually decreased from $5.45 per pound in 1852 to a price today of less than twenty cents per pound. Aluminum is one of the lightest metals in common use, weighing about one-third as much as iron. In its pure state, it is soft and ductile. It cuts and files easily and will bend without fracture. Aluminum resists corrosive action from the atmosphere and therefore retains a bright finish without other protection.

The fact that aluminum will not solder as easily as other metals will limit its use in art metal work. It is sold in sheets and coils of various thickness, gaged by the B & S gage. Its price per pound is less than copper and, since it is such a light metal, it is economical to use in the craft shop. Many shapes other than sheets may be obtained, such as bars, rods, tubes, plates, and many extruded shapes.

Sterling Silver.

Sterling silver is an alloy containing 92½ per cent silver and 7½ per cent copper. Sterling has a whitish color, solders readily with either hard

or soft solder and can be worked with the various metal tools as easily as copper. Sterling silver may be purchased in sheets 6″ wide. The gage most common is the B & S gage. Small pieces of this metal may be purchased cut to the desired dimensions.

Due to the relatively high cost of sterling silver, one must limit its use to small ornaments. The beginner may learn all the metalcraft techniques by using less expensive metals.

Pewter.

Pewter, or Britannia metal is an alloy of tin, antimony, and copper. Most present-day pewters contain approximately 90 per cent tin, about 1.5 per cent copper and the balance antimony. Its melting point is approximately 430° F., depending upon the manufacturer.

Pewter is a softer and heavier metal than the other metals used in metalcrafts. Pewter will resist corrosion almost indefinitely. Contrary to common opinion, pewter has a high resistance to the action of chemicals contained in foods and drinks. Utensils may be used with foods without any fear of poison.

Pewter may be purchased in sheets 18″ x 24″ or in ready-cut discs in diameters from 3″ to 12″. The thickness of pewter is gaged by the B & S gage. Pigs may be purchased for casting.

Steels.

Mild steel is an inexpensive material for use in the metalcraft shop. It is a steel which is malleable and ductile and therefore can be worked into various shapes while cold without fracture.

Band iron, or strap iron, is a form of mild steel which may be purchased in sizes ranging from straps as thin as 1/16″ and as narrow as 1/4″. This metal has a dull black oxide finish and is quite ductile and comparatively easy to bend without heating. This form of iron is used to make so-called "wrought iron" articles. It may be drilled, filed and sawed easily, and can be bent upon itself without cracking.

Black iron sheets are a form of mild steel that has the same physical qualities as band iron. Its thickness is gaged by the U.S. Standard sheet iron and steel gage (see table on p. 283) and it is manufactured in standard sheets from 30″ to 36″ wide and in lengths up to 8′. Black iron is used in conjunction with band iron for projects of "wrought iron".

Tin plate is a sheet of black iron with a very thin coating of tin on each side. Tin plate is furnished in sheets measuring 20″ x 28″ and in thick-

nesses as measured by the tin plate gage (see table on p. 283). It is interesting to note that it has been standard practice to use about 1½ lbs. of tin to 100 lbs. of iron. The chief quality of tin plate is the brightness of its surface which is a result of the plating. This process gives the metal a corrosion-resistant finish. The chief use of the metal is in the manufacture of tin cans and kitchen utensils. It bends, flanges, burrs and solders easily but, if heated above the melting point of tin, it will lose its plating.

Tool Steel.

Steel with a high carbon content which can be hardened and tempered is known as *tool* steel. This steel cannot be distinguished from iron or mild steel by its outward appearance; however, a piece of tool steel may be tested by grinding. If the grinding sparks explode at the ends, then the piece being tested is tool steel. Compare the sparks from a piece of mild steel with a piece which is known to be tool steel and observe the difference in the sparks. The best means of positive identification, however, is to heat the steel to a "cherry" red and quench it in water. If the piece hardens, it is tool steel; if not, it must be some form of mild steel. Tool steel is made in bars of many different cross-sectional shapes. Hexagonal, octagonal, and round bars are especially useful for making chisels and chasing tools. Tool steel is usually sold by the pound. It is a good policy to paint an identifying color on the surface of the tool steel when it comes in the shop. This precaution will prevent errors in substituting other steels for tool steel.

Solder.

The various alloys produced from tin and lead are usually known as soft solders. The alloy consisting of 50 per cent tin and 50 per cent lead is known as common solder. This solder melts at about 430° F. and is commonly sold in the form of a bar or wire. Common wire solder is manufactured either with a core which contains the flux or as a solid wire. The two most common cored solders are acid core and rosin core. These flux-cored solders are handy for certain jobs; however, they are not suitable, for the most part, in the metalcraft shop.

Pewter solder is a soft solder with a lower melting point than common half-and-half solder. This solder is made of 60 per cent tin, 40 per cent lead, and melts at approximately 340° F. A still lower melting point may be obtained with a 63-37 tin-lead alloy solder. The 60-40 is the best type

to stock when only one solder is to be used on the pewter. It is sometimes necessary when soldering pewter to use two or more solders with different melting points in order not to melt one joint when soldering the next. This method of soldering is known as successive soldering. For this purpose one may purchase a tin-lead-bismuth solder which has a still lower melting point.

Solders called *hard solders* or silver solders are stronger and have a higher melting point. These solders contain various metals in their alloys. Brazing rod is a common form of hard solder which is an alloy of copper and zinc. Silver solders are high in tin content and contain some silver. A special solder is available for soldering aluminum. This solder comes with the correct flux provided. Care should be taken when using this solder to follow the directions carefully as success will depend on the correct procedure.

Flux.

The least film of grease, dirt or oxide on the metal to be soldered will prevent the solder from sticking. Therefore, the surface must be cleaned and coated with some substance which will reduce the oxide. For this purpose, a soldering flux is used. The most common one is zinc chloride. This is made by allowing a small amount of muriatic acid to dissolve all the zinc that it will, and then straining, and diluting with equal parts of water. The selection of the proper flux depends on the material to be soldered. Fluxes which work well on one metal may have no effect on another. Borax is used almost universally when silver-soldering all metals. The following is a table of common fluxes used when soft-soldering:

FLUXES USED FOR VARIOUS METALS

Material	*Flux*
Electrical work	Rosin
Tin plate	Ammonium chloride (Sal Ammoniac)
Black iron, Galvanized iron	Zinc chloride (Killed HCL)
Copper, Brass	Rosin or ammonium chloride
Aluminum, Stainless steel	Use special solder and flux provided with solder
Pewter	10 drops of HCL added to 1 oz. glycerin
German silver	Rosin or ammonium chloride

Iron Binding Wire.

Iron wire for binding together work that is to be soldered is essential in the metalcraft shop. It is available annealed in spools weighing either 1 or 4 oz. Wire sizes are gaged by the B & S wire gage (see table p. 283).

Round head, or button head, rivets are obtainable in fractional diameters from 1/8″ to 7/16″ and in varying lengths and are sold by the pound. Countersunk head iron rivets are available in the same sizes. Copper, brass, bronze, Allegheny metal, and other special types of rivets can be purchased in sizes as noted in manufacturers' catalogs.

Flat head copper rivets and burrs are available in seven different sizes, diameters ranging from No. 7 to No. 13 and lengths from 1/4″ to 1 1/2″.

Tinner's rivets are specified by the weight per thousand. For example, a 12-oz. rivet means that 1000 rivets weigh approximately 12 oz., or an 8-lb. rivet means that 1000 of these rivets weigh approximately 8 lbs. The size of the rivet varies from the 4 oz., which is 0.070″ in diameter and 1/8″ in length, to the 16 lb., which is 0.293″ in diameter and 17/32″ in length.

Finishing Materials.

Many materials are used to polish and prevent oxidation on a piece of metal. These materials are classified as finishing materials.

Steel wool is used to clean metal parts before applying acid-resist and is used to remove deep scratches from the metal before the piece is buffed. Steel wool is packaged in 1-lb. rolls and is available in several grades. Three good sizes to stock for all-round use are No. 000 extra fine, No. 0 medium, and No. 1 coarse. Steel wool that is packaged in pad form eliminates pulling the wool apart and is more economical.

Pumice powder is an abrasive used in scrubbing and cleaning metal. It is a white powder which is sold in 1-lb. packages in various coarsenesses. Fine, medium, and coarse grades are all useful in the craft shop. Pumice is also used to obtain various satin finishes on metal.

Emery is a rapid-cutting abrasive which is made from natural stone. It is available in the form of powder to be used much the same as pumice and also with a paper or cloth backing. Emery is also put up in the form of a paste stick for use as an abrasive in polishing on the buffing machine. The grain of emery is graded much the same as sandpaper: No. 000 being a fine grain, No. 1/2 medium, and No. 2 a coarse grain. The sheets of paper or cloth measure 9″ x 11″ and are sold by the quire. Emery paste

sticks for buffing come only in one grit and are used in the ruffing operation only. Dry emery powders are sold by the pound.

Buffing compounds, as the name implies, are abrasives used on buffs for the removal of scratches and other minor imperfections from the surface of metal or other materials in order to produce a high luster on the finished piece. In addition to emery paste, there are three common kinds of buffing compounds which are necessary in order to produce the highest possible luster. *White diamond dust* compound is used to "cut down" and polish practically all of the metals used in the metalcraft shop. This compound is especially efficient on aluminum and pewter. *Tripoli* is a reddish-brick-colored compound which is the most widely used polishing agent for "cutting down" brass, copper, aluminum, German silver, and sterling. *Jeweler's rouge* is a red composition used as a final polishing agent. Rouge is different from other polishing compounds in that it does not "cut down" the stock but it burnishes the metal surface. For this reason, jeweler's rouge is especially useful in polishing articles made of silver and gold.

Liver of sulphur is a chemical used to obtain an oxidized surface on metals. It is sold by the pound. The large chunks are broken up and dissolved in water for use as it is needed.

Wax is used as a protection on the surface of the metal to retard tarnishing. Ordinary floor paste wax is a good type to stock. This can be obtained in 1-lb. cans.

Lacquer is used to prevent tarnishing of the surface of polished metal objects. Metal parts which are lacquered will withstand a good deal of handling and still retain their original luster. Clear metal lacquer is sold by the gallon or in smaller quantities. When ordering lacquer, include *lacquer thinner.* This is the solvent for lacquer and may be used to thin the lacquer, to clean the brush, and to clean the metal before the lacquer is applied.

Etching Equipment.

Material used in the metalcraft shop for preparing the metal for etching and etching a design in the metal may be classified under two headings: (a) Those materials used to resist the acid, and (b) etching mordants, or acids.

Black asphaltum is the most common acid-resist used in the etching process. This varnish is sold in cans by the pint or quart. It is quite often too thick to use as it comes from the can, and therefore may need to be thinned with turpentine to the consistency required. There are a number

of commercial preparations on the market which may be used in place of asphaltum. The printer uses a resist called *stopping-out varnish* which works well in metalcraft work when the design is of unusually fine lines.

Nitric acid, used for etching copper, brass, German silver and many other metals, is sold at a chemical supply house or may be obtained in small quantities at the local drug store. It is usually obtained commercially concentrated in bottles of about 7 lbs.

Sulphuric acid, used to make up a pickling solution, may also be obtained as above.

Hydrochloric acid is used to make up fluxes for soldering various metals. This acid also may be obtained at a drug store; however, because of its limited use, it should be bought only in small quantities.

GAUGES IN USE IN THE UNITED STATES

Gauge No.	Washburn & Moen Steel Wire	American or Brown & Sharpe	U. S. Standard Sheet Iron & Steel	Birmingham or Stubbs Iron Wire and Sheets	Morse Twist Drill and Steel Wire	Wood and Machine Screws	Tin Plate	Zinc Plate
0000000	.490		.500					
000000	.4625		.469					
00000	.4305		.438					
0000	.3938	.460	.406	.454				
000	.3625	.4096	.375	.425		.032		
00	.3310	.3648	.344	.380		.045		
0	.3065	.3249	.313	.340		.058		
1	.2830	.2893	.281	.300	.228	.071		.002
2	.2625	.2576	.266	.284	.221	.084		.004
3	.2437	.2294	.250	.259	.213	.097		.006
4	.2253	.2043	.234	.238	.209	.110		.008
5	.2070	.1819	.219	.220	.2055	.124		.010
6	.1920	.1620	.203	.203	.2040	.137		.012
7	.1770	.1443	.177	.180	.2010	.150		.014
8	.1620	.1285	.172	.165	.1990	.163		.016
9	.1483	.1144	.156	.148	.1960	.176		.018
10	.1350	.1019	.141	.134	.1935	.189		.020
11	.1205	.0907	.125	.120	.1910	.203		.024
12	.1055	.0809	.109	.109	.1890	.216		.028
13	.0915	.0720	.094	.095	.1850	.229		.032
14	.0800	.0641	.078	.083	.1820	.242		.036
15	.0720	.0571	.070	.072	.1800	.255		.040
16	.0625	.0508	.0625	.065	.1770	.268		.045
17	.0540	.0453	.0563	.058	.1730	.282		.050
18	.0475	.0403	.0500	.049	.1695	.295		.055
19	.0410	.0359	.0438	.042	.1660	.308		.060
20	.0348	.0320	.0375	.035	.1610	.321		.070
21	.0317	.0285	.0344	.032	.1590	.334		.080
22	.0286	.0254	.0313	.028	.1570	.347		.090
23	.0258	.0226	.0281	.025	.1540	.360		.100
24	.0230	.0201	.0250	.022	.1520	.374	1XXXXX	.125
25	.0204	.0179	.0219	.020	.1495	.387	1XXXX	.250
26	.0181	.0159	.0188	.018	.1470	.400	1XXX	.375
27	.0173	.0142	.0172	.016	.1440	.413	1XX	.500
28	.0162	.0126	.0156	.014	.1403	.426	1XL–1X	1.000
29	.0150	.0113	.0141	.013	.1360	.439		
30	.0140	.0100	.0125	.012	.1285	.453	1C	
31	.0132	.0089	.0109	.010	.1200	.466	90 lbs. 95 lbs.	
32	.0128	.0079	.0101	.009	.1150	.479	85 lbs.	
33	.0118	.0071	.0094	.008	.1130	.492	80 "	
34	.0104	.0063	.0086	.007	.1110	.505	75 "	
35	.0095	.0056	.0078	.005	.1100	.518	65 lbs. 70 lbs.	
36	.0090	.0050	.0070	.004	.1065	.532		
37	.0085	.0044	.0066		.1040	.545	60 lbs.	
38	.0080	.0040	.0063		.1015	.558	56 "	
39	.0075	.0035			.0995	.571		
40	.0070	.0031			.0980	.584		
41	.0066				.0960	.597		
42	.0062				.0935	.611		
43	.0060				.0890	.624		
44	.0058				.0860	.637		
45	.0055				.0820	.650		
46	.0052				.0810	.663		
47	.0050				.0785	.676		
48	.0048				.0760	.690		
49	.0046				.0730	.703		
50	.0044				.0700	.716		

TINNER'S RIVETS

Size	Dimensions	
Weight per 1000 lbs. and oz.	Length	Diameter
6 oz.	9/64"	.080
8	5/32	.090
10	11/64	.094
12	3/16	.101
14	3/16	.109
1 lb.	13/64	.115
1¼	7/32	.120
1½	15/64	.125
2	17/64	.140
2½	9/32	.147

DECIMAL EQUIVALENTS

1/64—.015625	17/64—.265625	33/64—.515625	49/64—.765625
1/32—.031250	9/32—.281250	17/32—.531250	25/32—.781250
3/64—.046875	19/64—.296875	35/64—.546875	51/64—.796875
1/16—.062500	5/16—.312500	9/16—.562500	13/16—.812500
5/64—.078125	21/64—.328125	37/64—.578125	53/64—.828125
3/32—.093750	11/32—.343750	19/32—.593750	27/32—.843750
7/64—.109375	23/64—.359375	39/64—.609375	55/64—.859375
1/8—.125000	3/8—.375000	5/8—.625000	7/8—.875000
9/64—.140625	25/64—.390625	41/64—.640625	57/64—.890625
5/32—.156250	13/32—.406250	21/32—.656250	29/32—.906250
11/64—.171875	27/64—.421875	43/64—.671875	59/64—.921875
3/16—.187500	7/16—.437500	11/16—.687500	15/16—.937500
13/64—.203125	29/64—.453125	45/64—.703125	61/64—.953125
7/32—.218750	15/32—.468750	23/32—.718750	31/32—.968750
15/64—.234375	31/64—.484375	47/64—.734375	63/64—.984375
1/4—.250000	1/2—.500000	3/4—.750000	1—1.000000

MELTING POINTS OF ALLOYS OF TIN AND LEAD

Parts Tin	Parts Lead	Melting Point in ° F.
3	1	367°
4	1	372°
5	1	381°
2	1	385°
1	1 (half and half)	466°
1	0 (pure tin)	475°
1	3	552°
0	1 (pure lead)	618°

Chapter II

TOOLS USED IN THE METALCRAFTS

Marking, Measuring and Layout Tools.

The *scratch awl,* or scriber, is a sharp-pointed tool made of tool steel. It has a hardened point so that it can be used to mark lines on the surface of metals. This tool is made in a large variety of sizes and shapes. It may have a handle made of wood, plastic, or metal, or it may be of the double-pointed type without a handle.

Center punches are made from tool steel. They are used to make marks or dents in the surface of the metal. A dent may be used to give an accurate starting point when drilling a hole or to locate a center accurately before using the dividers in laying out an arc or a circle. If the center punch is used to locate the center of a circle or arc, be sure that the mark does not injure the surface of a piece of metal which is later to be polished. The metal that is to be punched should be laid on an anvil or a block of smooth metal in order that the metal can be marked with a minimum of deforming. Center punches for use in the craft shop should be about 4″ long with a point about $\frac{3}{32}$″ in diameter. The point is sharpened on the grindstone at an angle of about 90 degrees.

The *prick punch* is a tool similar to the center punch except the point is ground at an angle of 60 rather than 90 degrees, and it is generally used for lighter work.

The *scale,* or *rule,* should be made of spring-tempered steel and is usually provided with graduations in eighths, sixteenths, thirty-seconds, and sixty-fourths of an inch. The length of the scale should be at least 6″ for most work; however, the size of the projects to be made may require a longer one.

A *steel square* is an essential item in the metalcraft shop. It is used to lay out lines at right angles to an edge on the metal. There are many kinds of squares on the market; however, the one that is suitable for most purposes is the 12″ *combination square.* This square has an adjustable head and may be used as a marking gage to mark a series of lines parallel to an edge on the metal. It is also equipped with a scriber inserted in the handle, and may be used to mark or test angles of 45 degrees. Another type of square

that is handy to have in the shop is the *carpenter's*, or *framing*, square. This square, especially useful with large work since the longer blade is 24″ long, can be used as a long straight-edge in testing and laying out straight lines on metal.

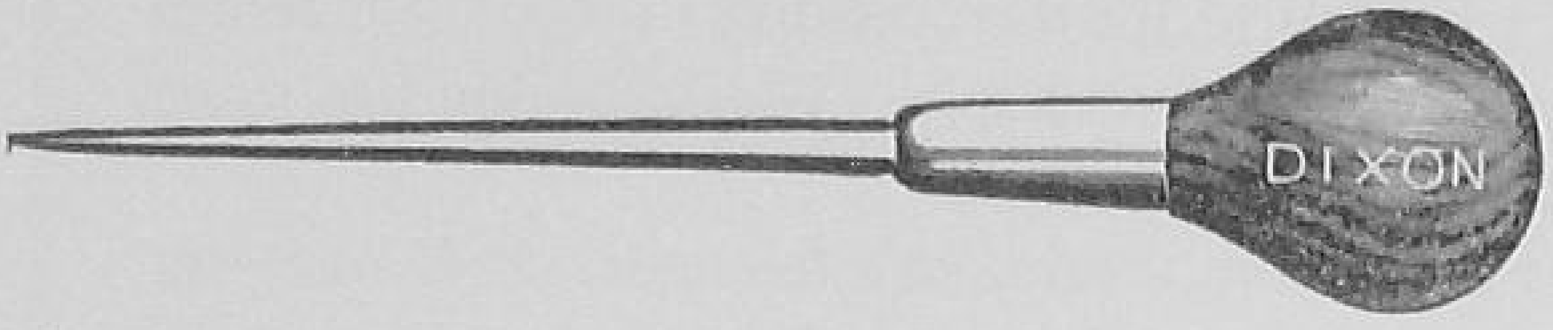
Dividers are instruments employed to lay out arcs of circles or circles on the surface of metal. The dividers may also be used to "step off" spaces of equal length on the metal. Two common types of dividers are the spring and the wing divider. The spring divider can be adjusted more accurately than the wing divider; however, the wing divider is more rigid than the former and therefore is generally preferred when working with the various art metals. Spring dividers may be purchased in 3″, 4″, 5″ or 6″ lengths, whereas the wing divider is usually available in larger sizes. A 6″ divider will make a circle 12″ in diameter.

Calipers are used primarily to measure the diameters of round objects. Spring calipers operate much the same as spring dividers. They are also available in the same sizes as the dividers. There are three kinds of calipers: (a) *outside calipers*, (b) *inside calipers*, and (c) *hermaphrodite calipers*. The outside caliper is used for outside work, whereas the inside caliper is used to measure the diameters of holes, etc. The hermaphrodite caliper is a layout tool, one leg of which is a caliper leg and the other a divider leg. This tool is especially useful in laying out and testing. The inside and outside calipers are available in both the spring and the friction type. The spring type is far superior to the friction type when accuracy is of prime importance; however, when rapid action with a reasonable degree of accuracy is required, the friction type is more easily set.

Surface Gage. The surface gage may be used in conjunction with a surface plate or a flat metal bench-plate. The point or scriber is set at a given height from the base, and the gage is moved about on the plate, marking the given height on a piece of metal. In the metal shop, the surface gage is usually used to "true up" a metal bowl that has been hammered. The surface gage is essentially a toolmaker's tool and therefore is considered to be a precision tool. The use to which the surface gage is put in the metalcraft shop does not require a great deal of accuracy; therefore it is not essential to purchase the best quality. A good size for most work is a gage with a 6″ spindle.

Hammers and mallets.

The hammer and mallet are probably the most important tools in the metalcraft shop. The hammer has many uses. It may be used to hit an-



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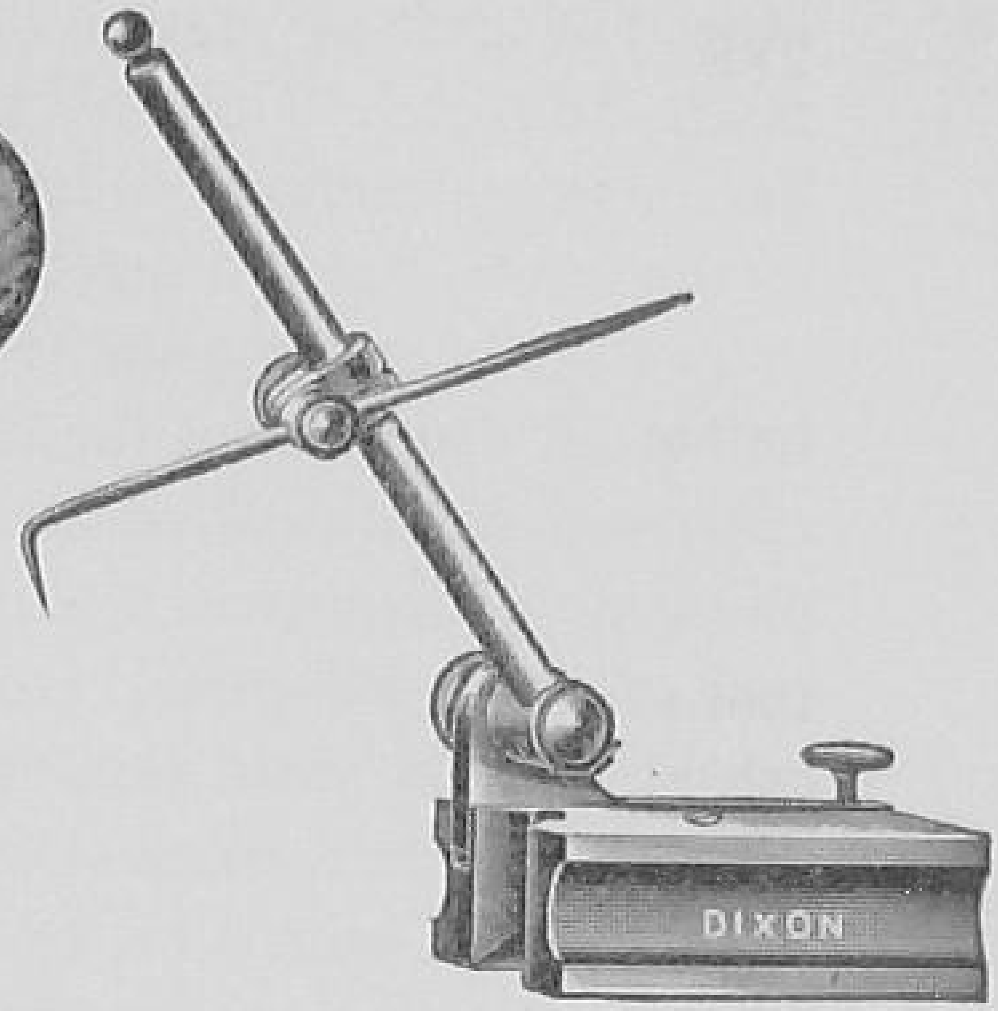

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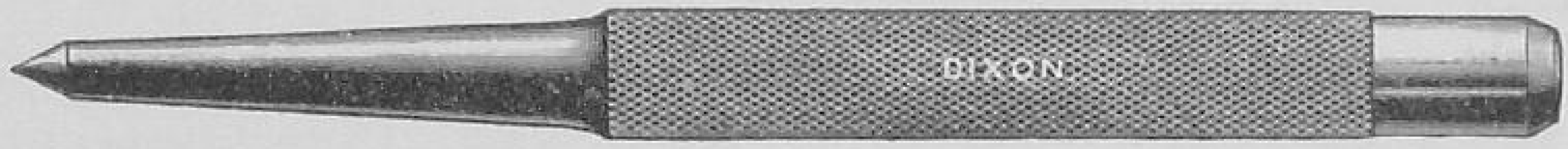

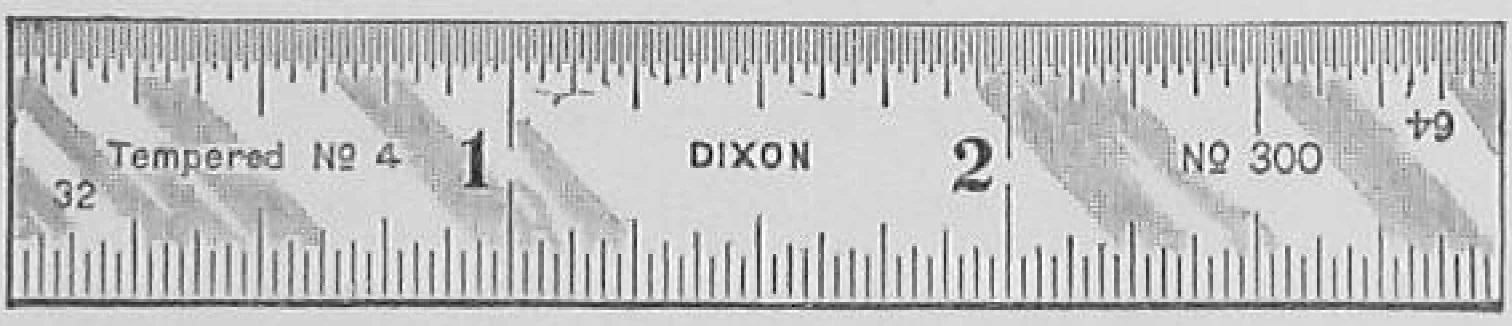

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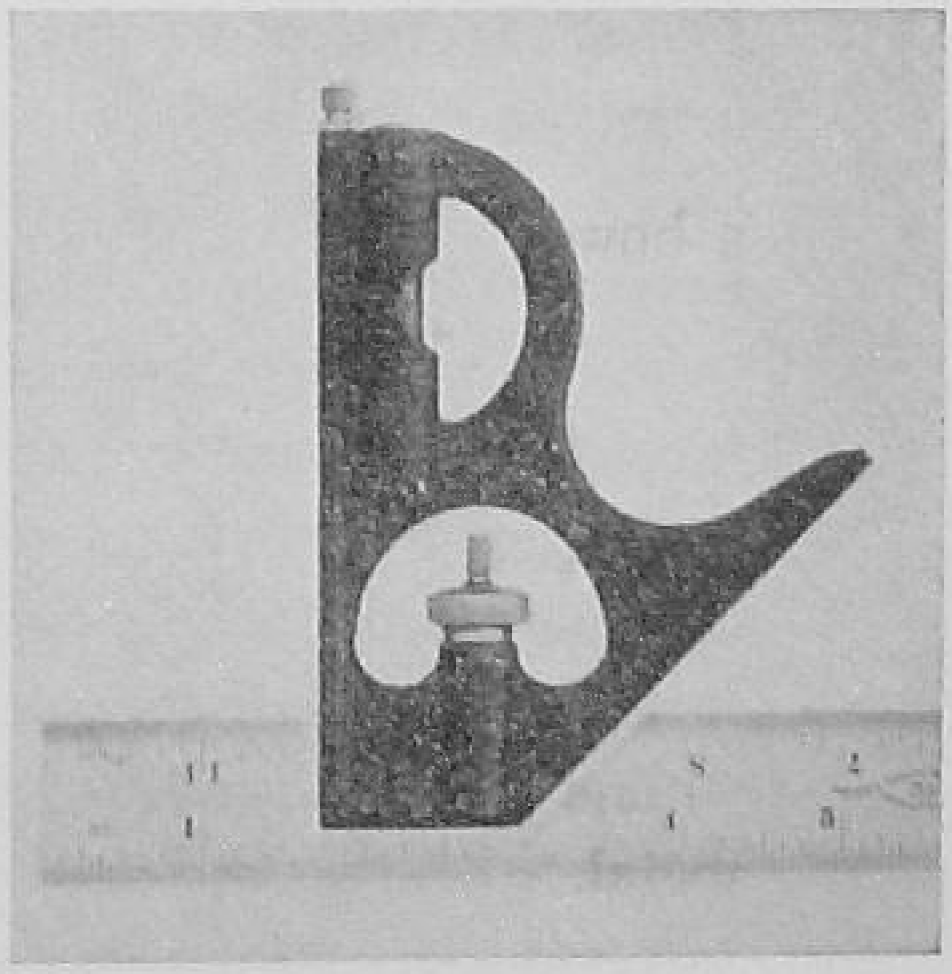

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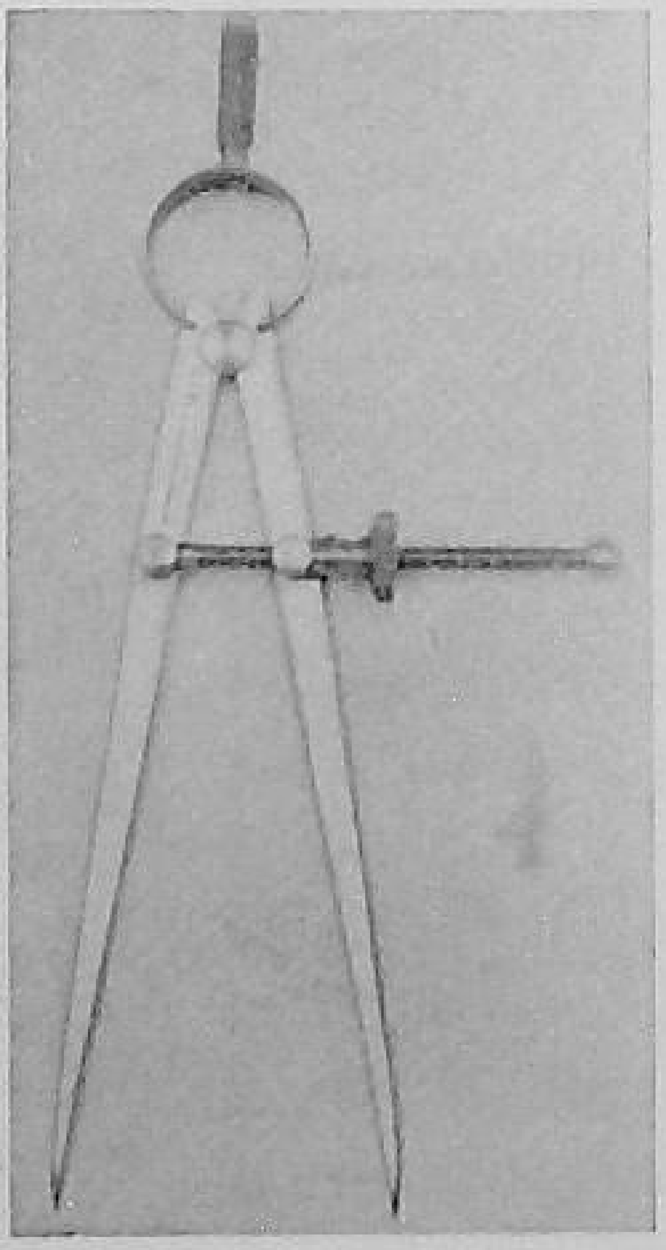
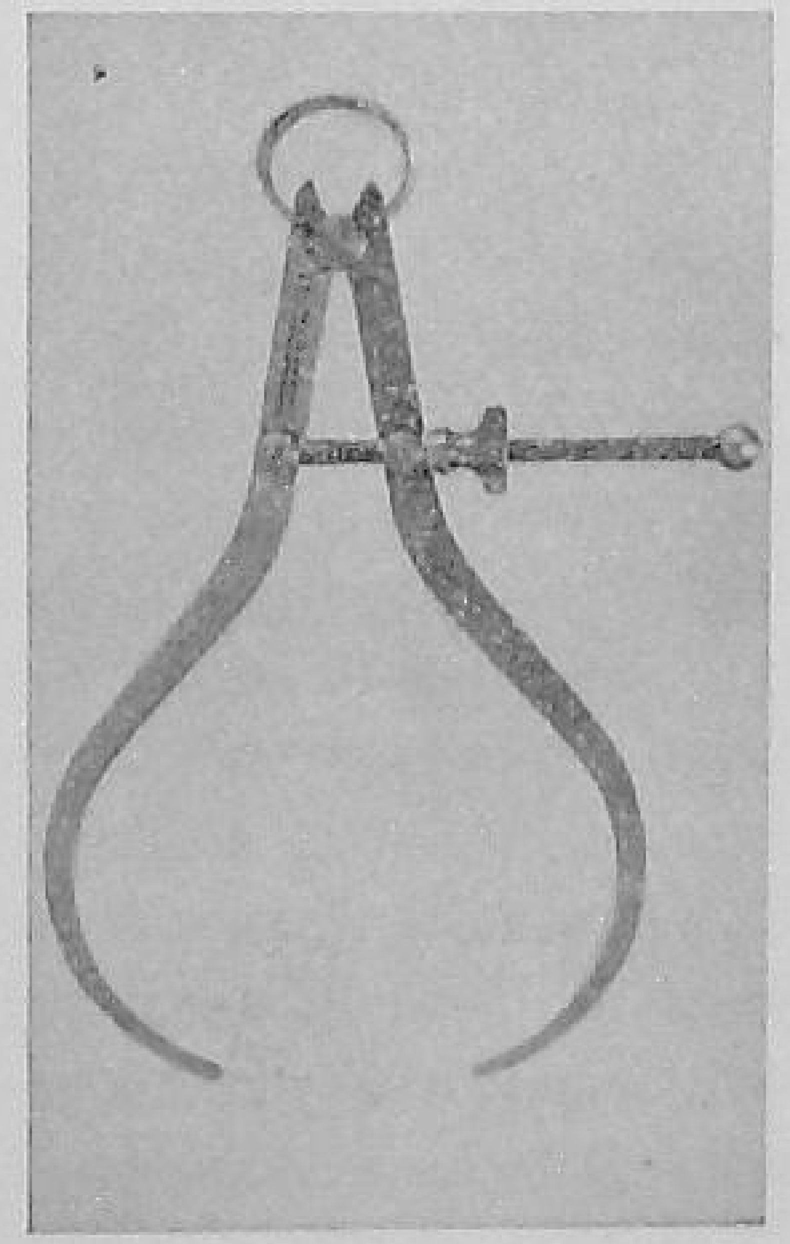




f

g

Fig. 1. Measuring and layout tools.

a. Scratch awl
b. Center punch
c. Scale
d. Surface gage
e. Combination square
f. Dividers
g. Outside calipers

other tool such as a punch or a chisel or it may be used directly to form or mark the metal. The mallet is used to form or bend the metal. There are hammers and mallets of many forms and shapes. The following are some of the kinds that are used on metalcraft work.

The *ball peen hammer* is a common machinist's hammer. It is made of tool steel. One end of the hammer head is spherical in shape whereas the other end has a face which is slightly convex. This hammer serves as an all-purpose hammer in the craft shop. It may be used to strike other tools such as the cold chisel, chasing tools, or punching tools. The ball end can be used to "head over" rivets or may, if no other hammer is available, be used to peen a piece of metal. These hammers are designated by their weight. Sizes from 8 oz. to 16 oz. are most common.

The *cross peen,* or *riveting,* hammer has a beveled peen at right angles to the handle. This hammer is used especially for riveting. It is generally light in weight and is most commonly used in sizes from 4 oz. to 12 oz.

A hammer especially designed to raise a piece of metal into the shape of a bowl is known as a *raising,* or *forming,* hammer. These hammers have varied forms and shapes depending on the use to which they are put. The lighter hammers are for small work such as spoon raising, whereas the larger ones are for larger pieces of work. Raising hammers have two faces which are convex in shape and whose corners are rounded so that there is a minimum chance of the hammer marking the metal as it is being formed.

The *planishing hammer* is used to remove blemishes from the surface of metal. This hammer may look a good deal like the raising hammer; however, if one inspects its surface, he will notice that the planishing hammer has faces which are polished to a mirror-like surface. This hammer has a limited purpose—producing various bright facets on the surface of finished work. These hammers are made with faces of varied spherical radii. Those with a small radius will produce a small facet on a flat surface, whereas those with a face which has a large radius will produce a large facet on a flat surface. Some planishing hammers have a face which is almost flat. These faces are designed to be used on convex surfaces such as the outside surfaces of a hammered bowl. When using the planishing hammer on flat work, one must place the work on a *planishing block* which is a flat piece of iron or steel that has been ground perfectly smooth and then polished to a mirror-like finish. This block is usually square or rectangular in shape and may be placed on the bench or held in the vise while planishing. Work other than flat work is planished over a stake of the proper shape. The same precautions must be taken to have a highly polished surface on

FIG. 2. Hammers for metalcraft.

the stake, since any mark which is present on the hammer or the stake will imprint itself into the metal that is being planished.

A *peening hammer* is much like a planishing hammer except for the fact that the peens or faces are of much smaller spherical radii. These hammers are used much in the same way as the planishing hammer, producing much smaller facets or peen marks on the surface of the metal.

The *chasing hammer* is a special hammer used to tap the chasing tools. These hammers are usually very light. A common pattern is the French type which is illustrated.

Mallets and *soft-face hammers* are used to strike the metal when bending or forming it into shape. *Mallets* are usually made of hard wood in

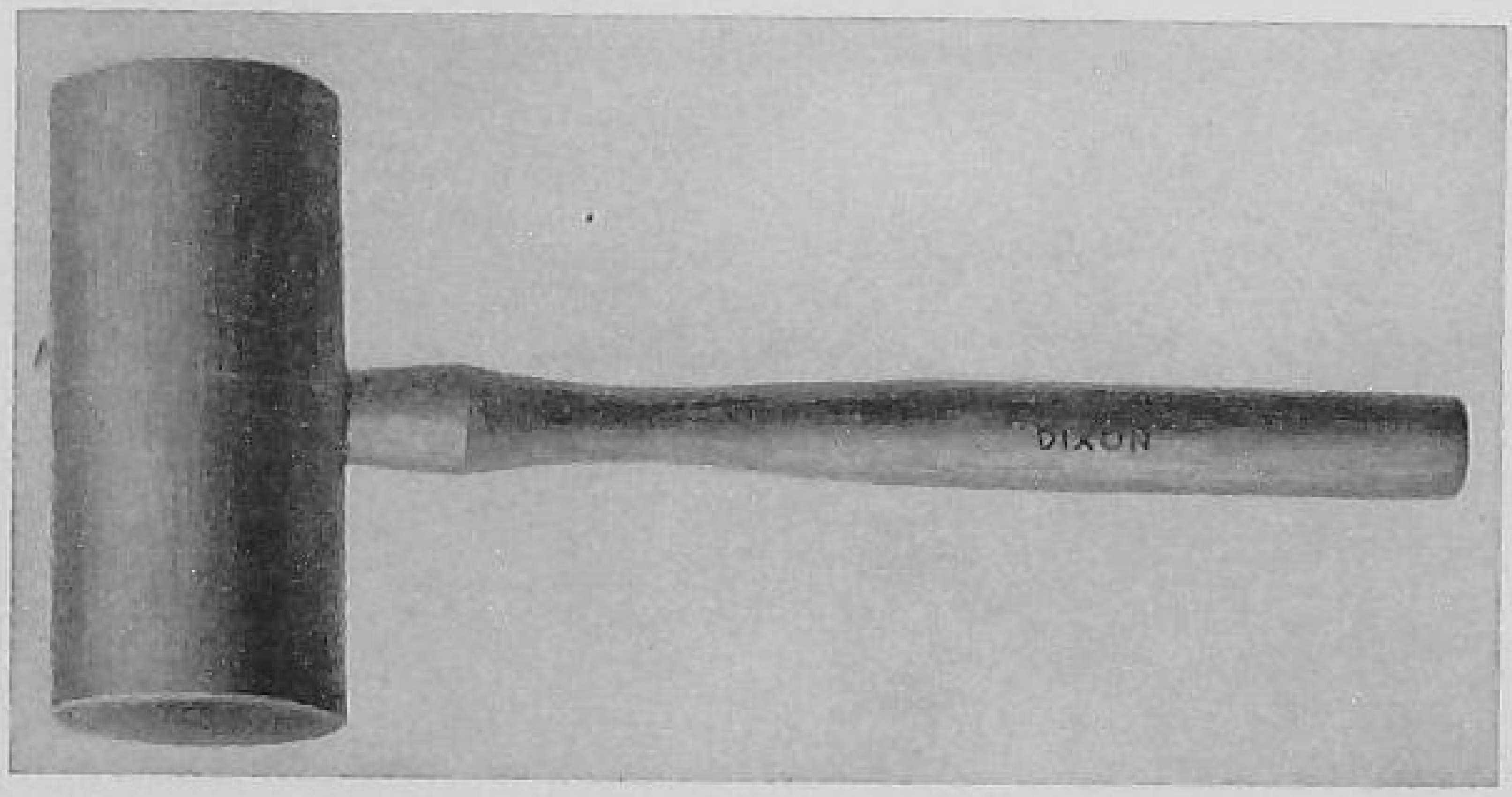


FIG. 3. Mallet.

various sizes and shapes, some especially shaped with a wedge end in order to be used for special work. *Wedge-shaped mallets* are often covered with a piece of leather to keep the wood from splitting and also to provide

FIG. 4. Soft-faced hammer.

a more even, soft pad at the end of the mallet. Mallet heads are also made of *fiber* or *raw-hide*. These mallets are usually more durable than wooden mallets. A *soft-face hammer* with replaceable plastic tips is quite useful in the craft shop.

A *machinist's vise* is an indispensable item of equipment in the craft shop. The vise is secured to the bench with bolts. The width and the

maximum opening of the jaw determine the size of the vise. An 8″ vise, therefore, will open and clamp a piece of material 8″ wide.

Small bench vises which clamp to the bench are useful when working on small work; however, a vise of this sort will not take the place of a large, sturdy vise. A *pipe vise* is especially useful for holding round bars and pipe while they are being cut and threaded.

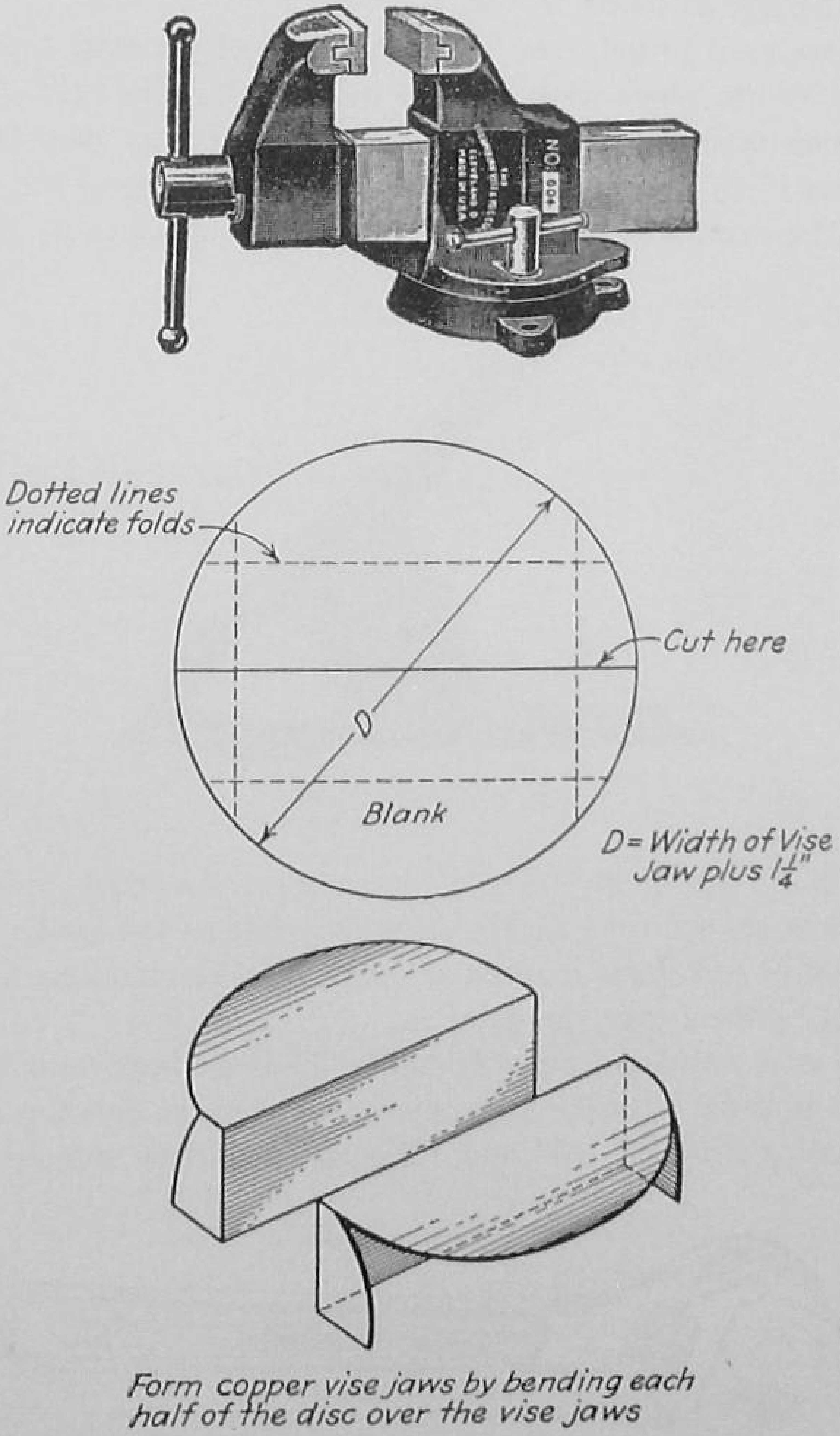


FIG. 5. Machinist's vise and copper vise jaws.

In order to protect the polished work from becoming marked by the rough or toothed vise jaws, it is a good plan to make a pair of soft metal jaws to cover the rough surface of the vise opening. A satisfactory pair of copper jaws can be made by cutting a circular disc of 18 gage copper 1¼″ larger in diameter than the width of the vise jaw. The disc is then cut in two halves on a diameter, and the pieces are placed in the vise and bent over the jaw as shown in Fig. 5.

Clamps are used to hold two or more pieces of material together or to clamp stock to the bench while work is being done. The *"C" clamp* is the most common type used in metalcraft. These clamps may be obtained in sizes from 1″ to 6″ and larger, depending on the size of the work to be clamped. The maximum opening of the clamp determines its size. *Spring*

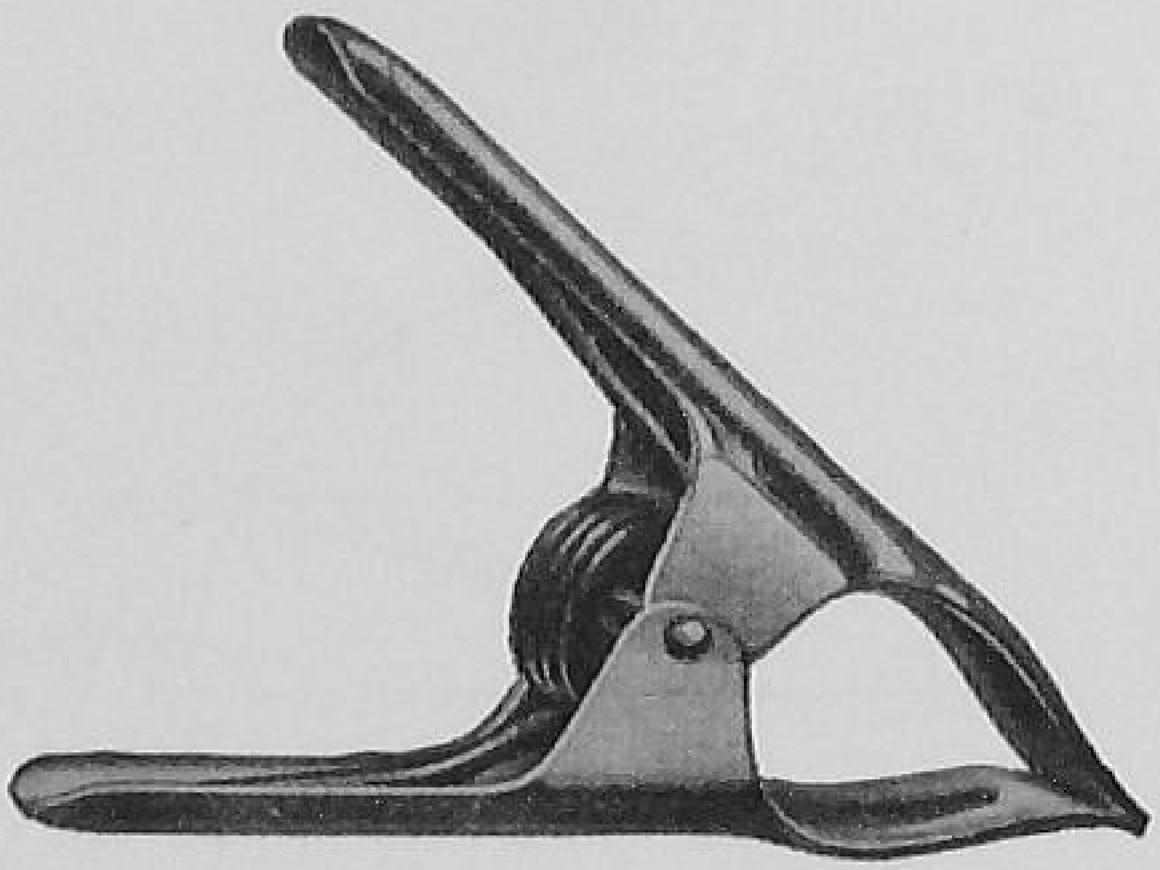


Fig. 6. Spring clamp.

clamps (Fig. 6) are handy to hold pieces when not much pressure is required. These clamps work on the same principle as the spring clothespin. A *bobby pin* or *cotter pin* is often a handy tool for clamping small pieces when soldering them over the flame.

A set of *adjustable end wrenches* (Fig. 7) is an important item in the metal shop in order to make adjustments and repairs on shop equipment. A set including a 6″, 8″, 10″ and 12″ sizes should be sufficient for most purposes.

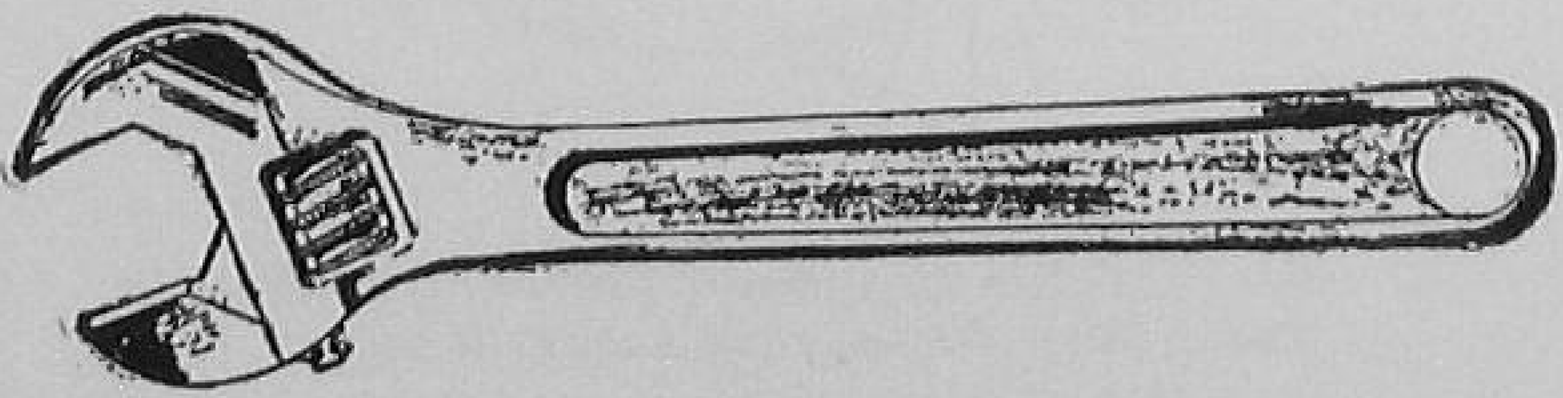
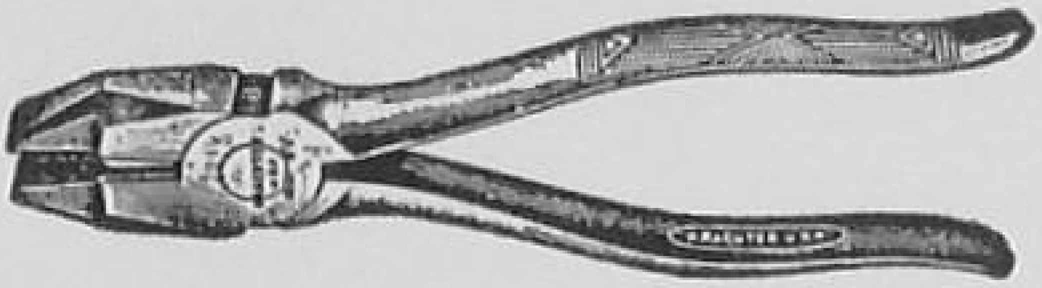


Fig. 7. Adjustable end wrench.

Pliers are used to cut, hold, and form work in the metalcraft shop. There are many sizes and shapes available. One must choose the type most useful for the work to be done. *Side-cutting pliers* can be used for cutting wire as well as for holding work. These pliers are made of tool steel and should not be used over a gas flame as the heat will be no longer effective. They are made in various sizes; a 6″, 7″, or 8″ plier will be best for all-round work. The capacity of these pliers is limited only to the largest size wire which one may cut with them without the help of additional leverage.

a



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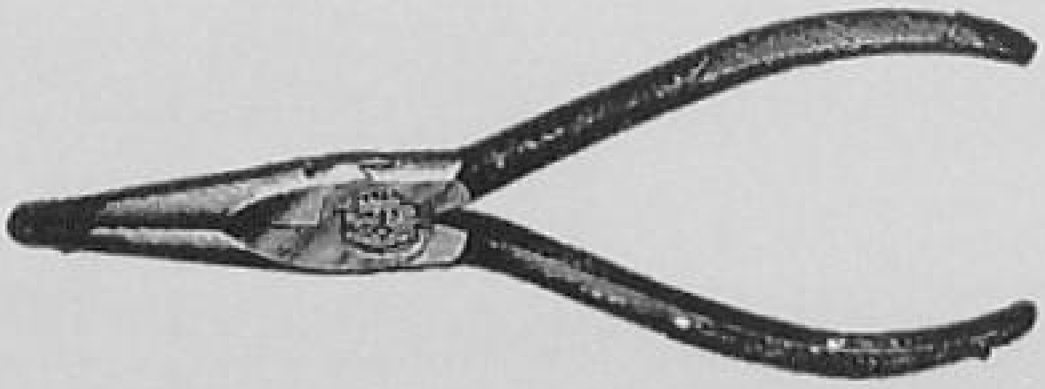


FIG. 8. Pliers.
a. Side-cutting. b. Gas. c. Half-round.

Gas pliers are a cheap type of plier and may be used to hold work over a flame while it is being heated. All other pliers should be kept away from fire since heat will spoil their tempered jaws.

Pliers used for bending and holding small work are classified by the shape of their "nose." Round-nose, flat-nose and half-round pliers are all useful in the metalcraft shop.

A *bending jig* is used in forming band iron when making wrought iron projects. The jig consists of a block of metal with two cylindrical pins set into its surface. One of these pins is usually adjustable for the thickness of the metal being used. The bending jig is held in the jaws of a machinist's vise when being used and the metal is bent in the jig by hand. Never use a hammer on metal being bent in the jig as the jig is not constructed for use with a hammer.

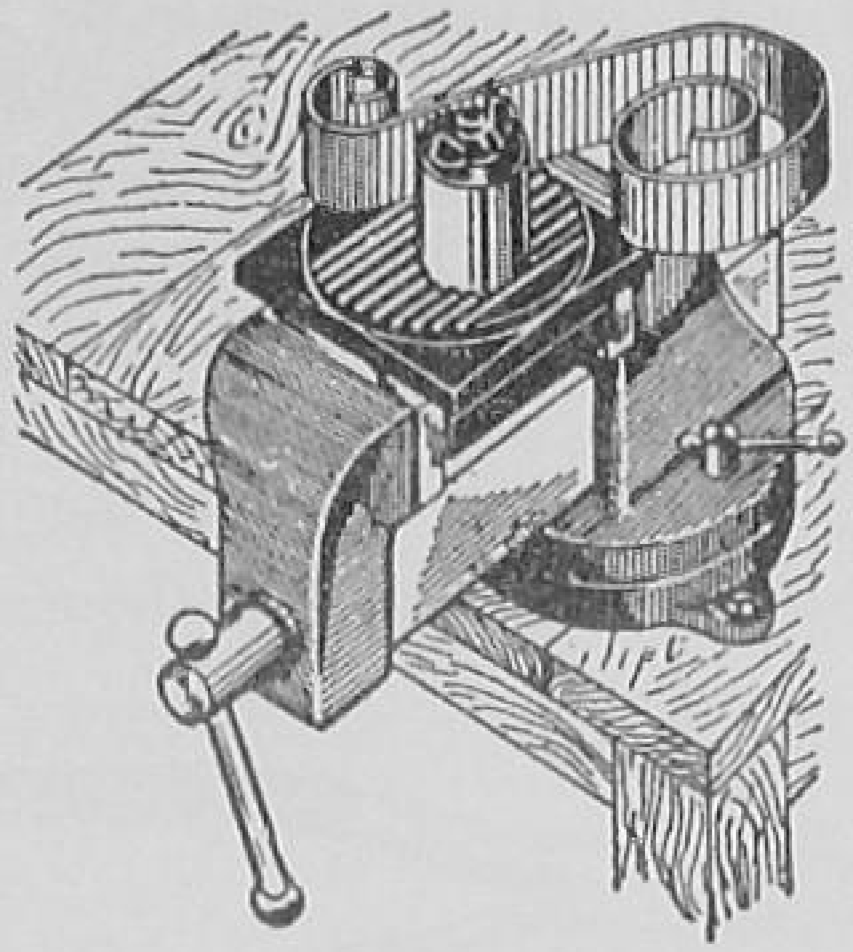
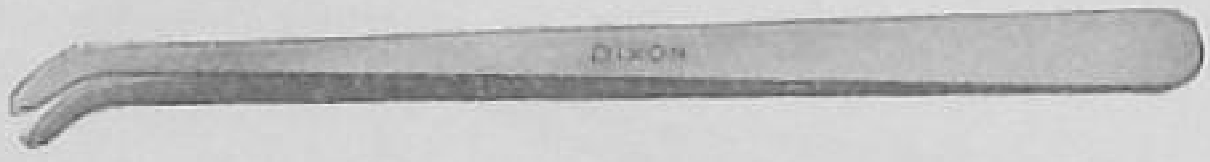


Fig. 9. Bending jig.

Tongs are used to hold work that is being heated and also to fetch work from acid or alkali solutions. Tongs are made of mild steel and in a large assortment of sizes and shapes. Fig. 10 shows two tongs most commonly used in metalcraft work.

a



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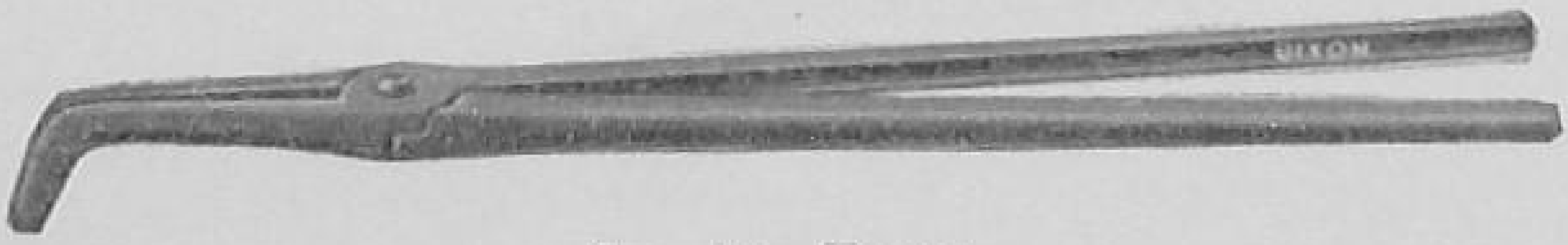


Fig. 10. Tongs.

a. Tongs for removing work from acids   b. Bent-nose tongs

Cutting Tools.

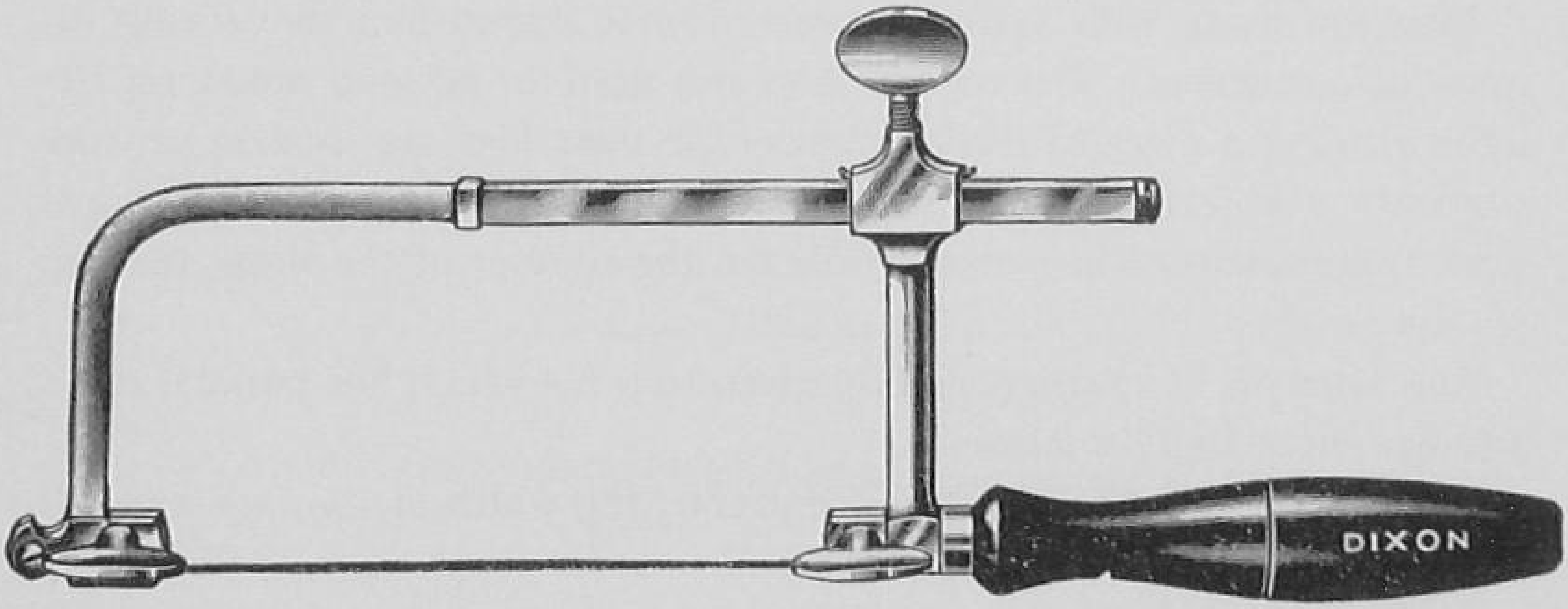
Saws for cutting metal are made with a finer tooth than woodworking saws because they are generally used on thinner stock. Metal saws are made also with a replaceable blade which is discarded when dull rather than resharpened.

The *hack saw* (Fig. 11) consists of an adjustable frame which is usually fitted with a pistol-grip handle. The blade usually is 8″ or 10″ long and may have 18, 24, or 32 teeth per inch. For most work in cutting thin stock and tubing, the 32-tooth blade is most satisfactory; however, in cutting bar steel of greater thickness, the 24-tooth blade may be used. Blades are made of either carbon tool steel or a special high-speed steel which will not dull as quickly but is more brittle. The tool steel blade is most satisfactory

for the general run of work. Hack saw blades are placed in the saw frame so that the teeth point away from the handle. Blades are generally 7/16″ wide and .025″ thick.

FIG. 11. Hack saw.

The *jeweler's saw* (Fig. 12) has a frame shaped like the letter "C" which is designed to be used with jeweler's saw blades. The frame is ad-



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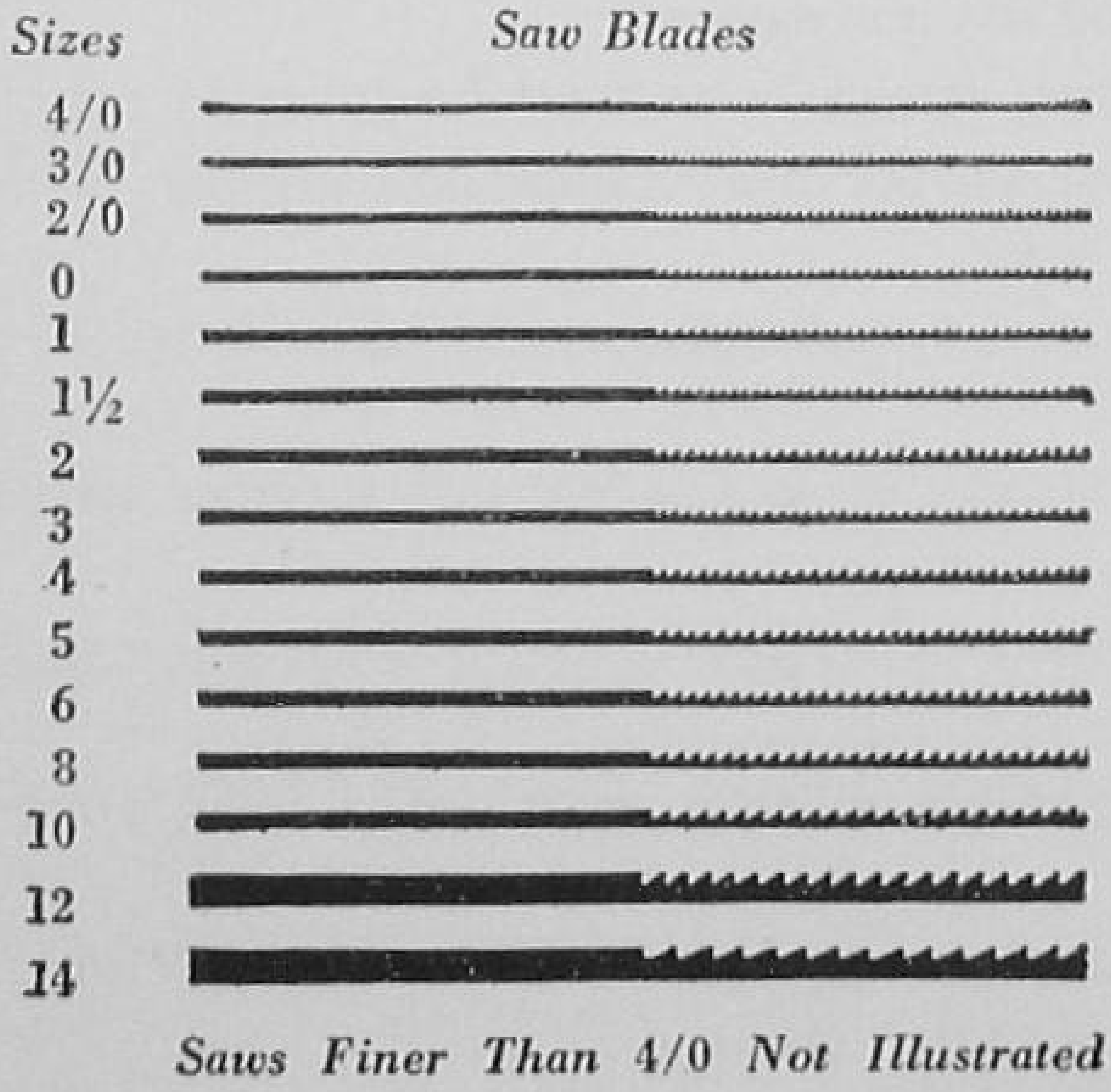


b

FIG. 12. Jeweler's saws.

a. Jeweler's saw frame
b. Comparative sizes of jeweler's saw blades.

justable to provide tension for the fine blade which is placed in the frame with the teeth pointing *toward* the handle. The depth of the throat governs the size of the frame. Frames are available in sizes ranging from 2¼″ to 12″. The particular use of the jeweler's saw is to saw or pierce thin metal strips. The smaller sizes are used for small jewelry, while the larger sizes are used on larger sized work. A 4″ saw can be used to saw to the center of a piece of metal 8″ in diameter.

The coarser blades are faster-cutting but do not produce the accurate detail that is possible with a fine blade. For sawing 16 or 18 gage copper, blades ranging from Nos. 2/0 to 5 are satisfactory. Blades are packaged by the gross but are also available by the dozen. Jeweler's saw blades are available in sizes from No. 8/0 to 14 and are 5″ in length.

Files.

Files are made with various cross-sectional shapes and in varying degrees of coarseness. The coarser files are used to remove metal rapidly when shaping a piece of work, whereas the finer files are used to produce a smooth, even surface. The selection of the proper file for the particular work is important. The closer the file fits the contour of the work, the better the result.

The *hand file* is a term generally given to a file which has parallel edges and has faces slightly convex.

The *flat file* is similar in shape; however, the width of the face narrows slightly toward the point.

A *pillar file* is similar to a hand file but narrower.

The *square file* is used for filing square or rectangular holes in metal.

The *half-round file* is flat on one surface and rounded on the other. This file can be used on round or flat work.

The *round,* or *"rattail," file* is used for enlarging round holes in metal or for filing rounded corners.

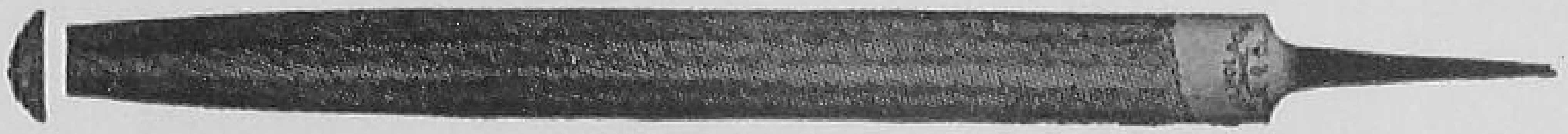
The *triangular file* is handy to use when finishing off surfaces which meet at less than right angles.

The *crochet file* has both edges rounded and is useful when filing near a rounded corner.

A *warding file* is a very thin flat file which is useful when filing a narrow slot in a piece of work.

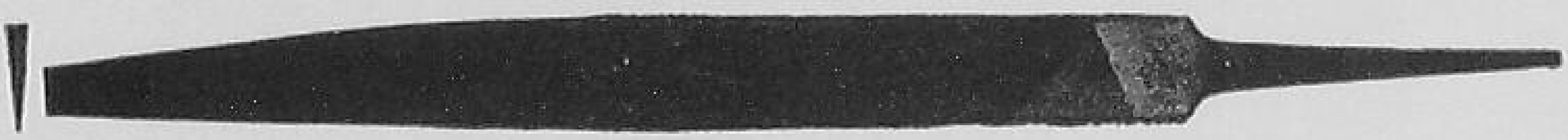
A *barrette file* has a flat triangular shape with teeth on one side only. This file is useful in finishing sharp internal corners.

A *knife file* is a file whose cross-sectional shape is like that of a knife. This file is also used on work with sharp internal corners.

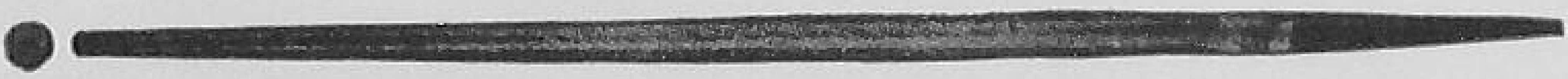


Half round file.

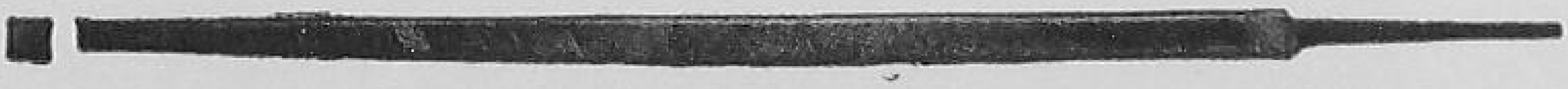
Triangular or three-cornered file.



Knife edge file.



Round or rat-tail file.



Square file.

FIG. 13. Files used in metalcraft.

The size of a file is indicated by its length, exclusive of the tang. Some of the above shapes are made with "safe" edges which are surfaces with no teeth. This enables one to use the file in the corner of a piece of work without filing the adjacent surface. The file teeth are either single- or double-cut. The single-cut, or *mill files* as they are sometimes called, are used for producing a good finish whereas the double-cut files are generally used for removing excess stock. The coarseness of cut on a file is graded under three classifications: the bastard or coarse cut; the second cut or medium; and the smooth cut or fine. When ordering a file, give (a) the type (cross-sectional shape), (b) the length, (c) the cut, (d) the coarseness of cut. File handles are always sold separately and should be supplied, since a good job cannot be done on work when the file is not handled.

Jeweler's *needle files* (Fig. 14) are small files made in most of the above shapes used for delicate and exacting jobs. These files are available with square or round handles in sizes 4″ to 6″ long and also in assortment sets of six or twelve common shapes.

FIG. 14. Jeweler's files.

Chisels.

The *cold chisel* is an impact tool made of tool steel, one end of which is tempered and sharpened for cutting metal. The cutting edge is made in various shapes for special uses. The common shapes are the *straight, cape,* and *diamond point* (Fig. 15).

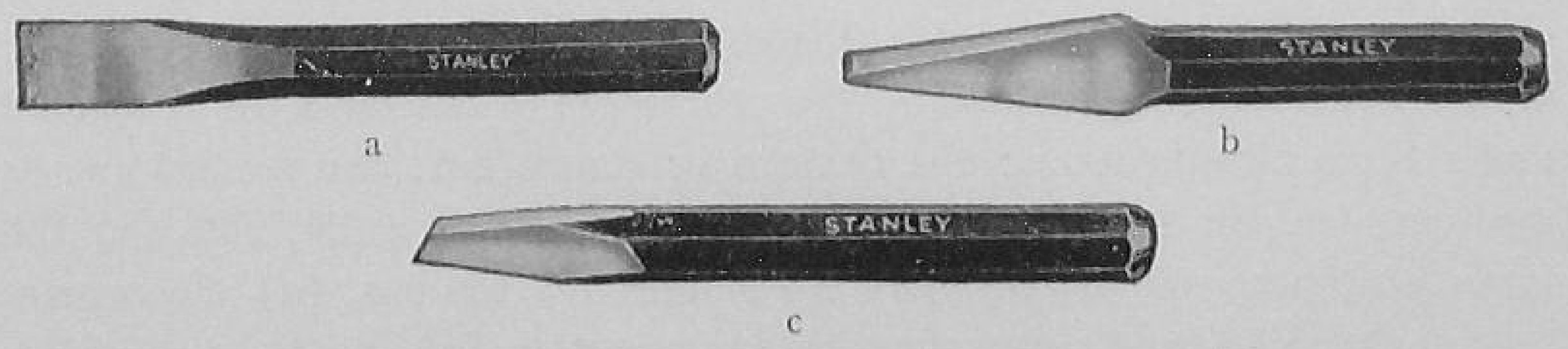


FIG. 15. Chisels.
a. Straight b. Cape c. Diamond point

Shears.

Bench shears are a large shear, one foot or leg of which is held in a bench vise or a slot in the bench. These shears are used on heavy metal (up to 16 gage) and are made 24″ to 39″ in length.

Tinner's shears, or *snips,* are used for small hand work for straight or outside curves (Fig. 16). These shears are most popular in sizes 8″ to 12″.

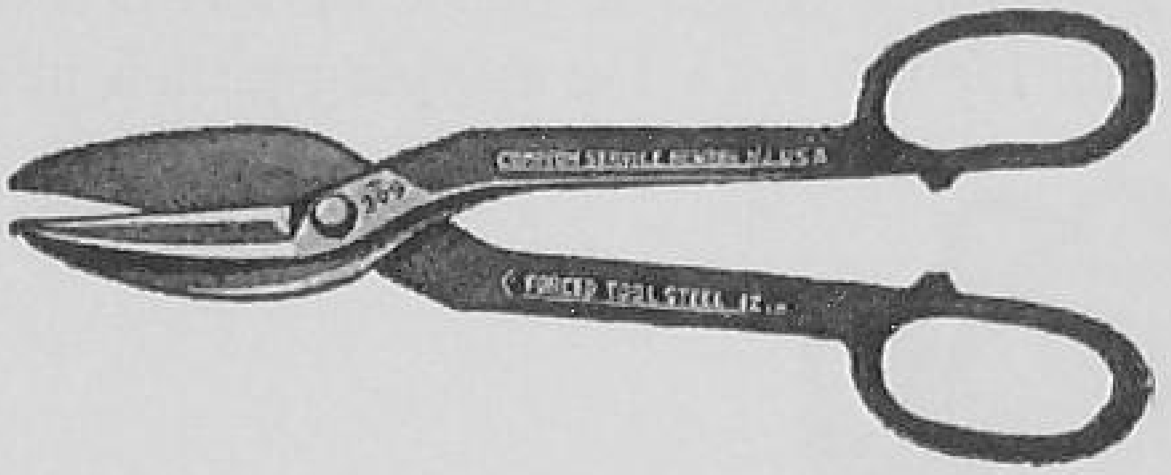


FIG. 16. Tinner's shears.

Aircraft snips are a special compound lever type of snip which cut well with a minimum of power. They are the best general-purpose snip to use around the craft shop for small work. They are available in either "left-" or "right-hand." The most common snip or shear has the lower blade on the left and cuts to the left when held in the right hand. The "right-hand" snip is made with the lower blade on the right and will cut to the right.

Punches.

Solid punches are used to cut or punch holes in sheet metal. The cylindrical end is slightly tapered away from the point so that the hole that is punched is slightly larger than the diameter of the punch near the end. The end of this punch is ground square and flat. Solid punches are available in a number of sizes for various size holes.

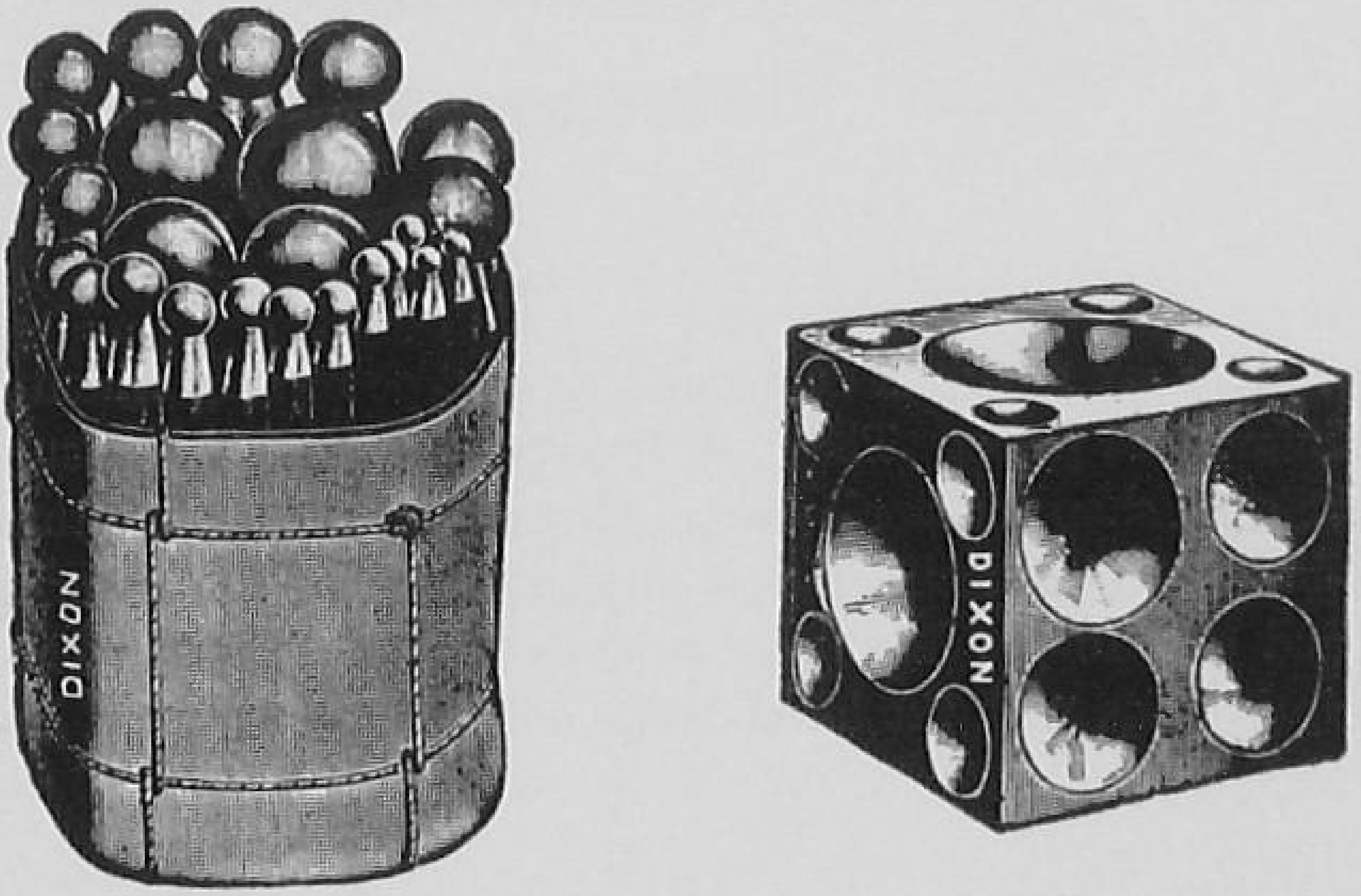
a

b

FIG. 17. Punches.
a. Solid punch b. Hollow punch

The *hollow punch* is a steel tool with a circular cutting edge used also to punch holes in sheet metal. It will punch larger holes than the solid punch and is available in sizes ½″ to 3″ diameter.

Dapping punches are used to form small hemispherical shapes in decorating objects made in the craft shop. *Dapping cutters* are used to cut small metal discs that are to be formed with the dapping punch and the *dapping die*. The dapping die is a block of metal with many concave spherical depressions for use with the dapping punch and cutter.



a b

Fig. 18. Dapping tools.

a. Dapping punches b. Dapping block

The *rivet set* (Fig. 19) is a tool used to produce a spherical shape on the end of a rivet after it has been headed over with a hammer. This tool is a bar of tool steel with a concave spherical depression. Various sizes are available for rivets of different diameters.

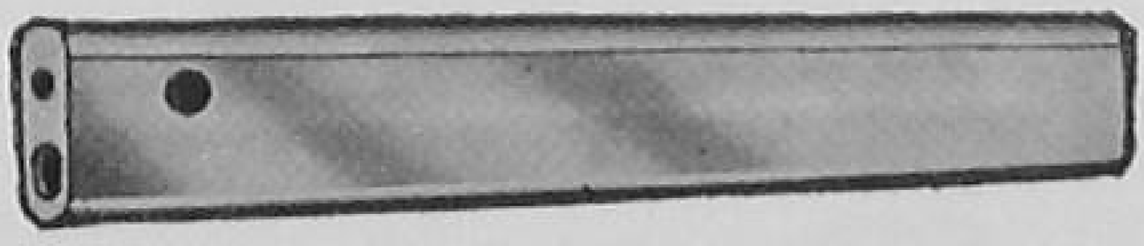


Fig. 19. Rivet set.

Drills.

Drills for metalcraft are available in various sizes. The two most common sets of drills are the fractional set and the numbered size set. A full set of fractional size drills, $\frac{1}{16}$″ to ½″ by $\frac{1}{64}$″, is the most handy set.

This set can be supplemented with a number size set ranging from No. 1 to No. 60. The number size set has a larger selection of in-between sizes which do not appear in the fractional set. Special number size sets of drills may be obtained up to a No. 80 drill which is only .0135″ in diameter. These very small drills are for use in a special drill press which has a very high-speed spindle.

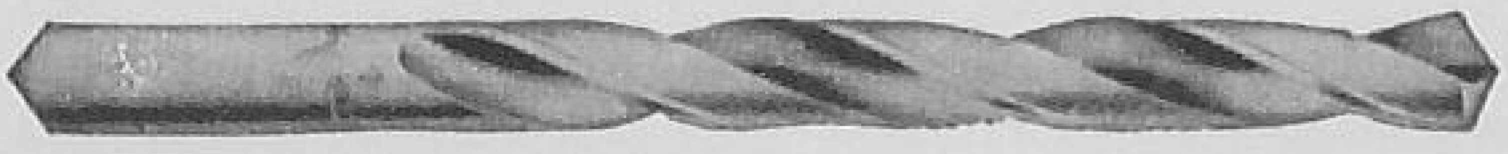


FIG. 20. Twist drill.

NUMBER SIZE TWIST DRILLS AND THEIR EQUIVALENT DIAMETER IN THOUSANDTHS OF AN INCH

No. by Gauge	*Decimals of 1 inch*	*No. by Gauge*	*Decimals of 1 inch*	*No. by Gauge*	*Decimals of 1 inch*	*No. by Gauge*	*Decimals of 1 inch*
1	.2280	21	.1590	41	.0960	61	.0390
2	.2210	22	.1570	42	.0935	62	.0380
3	.2130	23	.1540	43	.0890	63	.0370
4	.2090	24	.1520	44	.0860	64	.0360
5	.2055	25	.1495	45	.0820	65	.0350
6	.2040	26	.1470	46	.0810	66	.0330
7	.2010	27	.1440	47	.0785	67	.0320
8	.1990	28	.1405	48	.0760	68	.0310
9	.1960	29	.1360	49	.0730	69	.0292
10	.1935	30	.1285	50	.0700	70	.0280
11	.1910	31	.1200	51	.0670	71	.0260
12	.1890	32	.1160	52	.0635	72	.0250
13	.1850	33	.1130	53	.0595	73	.0240
14	.1820	34	.1110	54	.0550	74	.0225
15	.1800	35	.1100	55	.0520	75	.0210
16	.1770	36	.1065	56	.0465	76	.0200
17	.1730	37	.1040	57	.0430	77	.0180
18	.1695	38	.1015	58	.0420	78	.0160
19	.1660	39	.0995	59	.0410	79	.0145
20	.1610	40	.0980	60	.0400	80	.0135

TWIST DRILLS (FRACTIONAL SIZES) AND THEIR DECIMAL EQUIVALENT

Diameter Inches	*Whole Length, Inches*	*Decimal Equivalent*	*Diameter Inches*	*Whole Length, Inches*	*Decimal Equivalent*	*Diameter Inches*	*Whole Length, Inches*	*Decimal Equivalent*
1/32	1 7/16	.0312	3/16	3 1/2	.1875	11/32	4 3/4	.3437
3/64	1 11/16	.0468	13/64	3 5/8	.2031	23/64	4 7/8	.3593
1/16	2 1/2	.0625	7/32	3 3/4	.2187	3/8	5	.375
5/64	2 5/8	.0781	15/64	3 7/8	.2343	25/64	5 1/8	.3906
3/32	2 3/4	.0937	1/4	4	.25	13/32	5 1/4	.4062
7/64	2 7/8	.1093	17/64	4 1/8	.2656	27/64	5 3/8	.4218
1/8	3	.125	9/32	4 1/4	.2812	7/16	5 1/2	.4375
9/64	3 1/8	.1406	19/64	4 3/8	.2968	29/64	5 5/8	.4531
5/32	3 1/4	.1562	5/16	4 1/2	.3125	15/32	5 3/4	.4687
11/64	3 3/8	.1718	21/64	4 5/8	.3281	31/64	5 7/8	.4843
						1/2	6	.5

When drilling work in places where no electric current is provided, a *hand drill* (Fig. 21) is used with the above drill points. Most hand drills have a capacity of 0″ to ¼″. Some hand or *breast drills* have larger capacities.

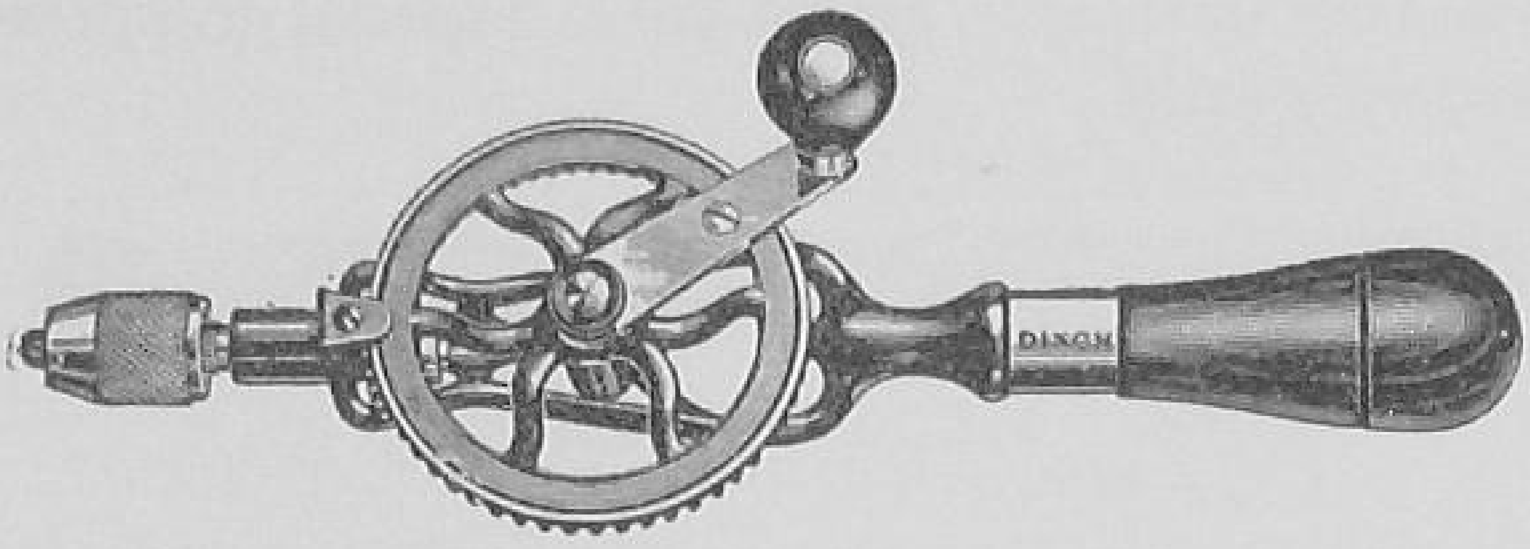


Fig. 21. Hand drill.

Countersinks (Fig. 22) are used to make a conical depression in the surface of the metal through which a hole has already been drilled. These are used especially on holes that are to receive a flat-head screw. The correct countersink for this purpose is one with an 82-degree included angle which is the angle of the flat-head screw.

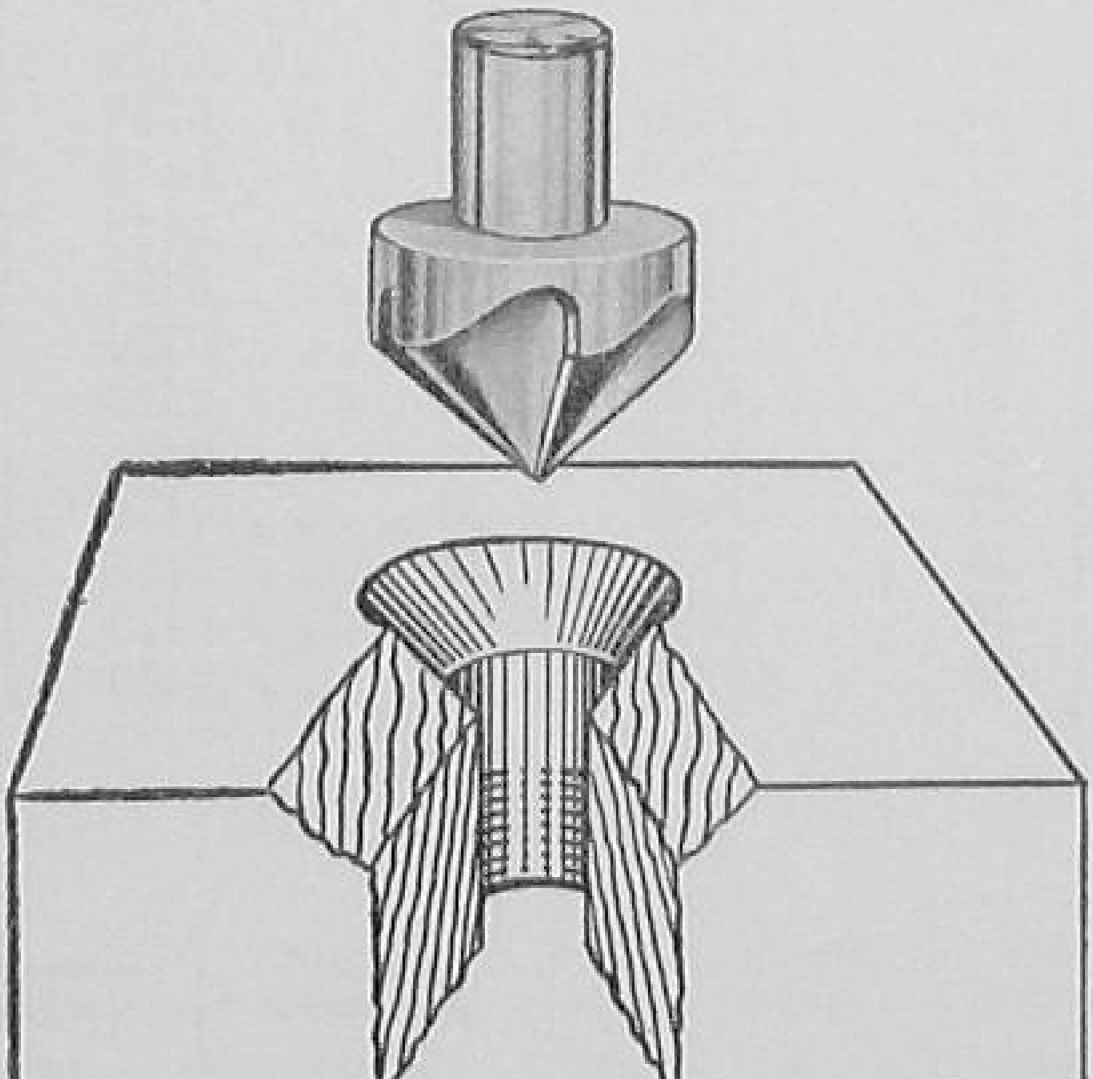


Fig. 22. Use of a countersink.

Taps and Dies.

A *tap* is a piece of round tool steel with a thread on one end and a square shank on the other. The threaded portion is fluted with grooves cut across the threads and parallel to the axis. These grooves form cutting edges on

the threaded part and allow a space for removal of chips. Taps are available in three forms: the taper or starting tap, the plug tap and the bottoming tap. A *tap wrench* is a handle used to hold the tap while turning the tap into the tap hole.

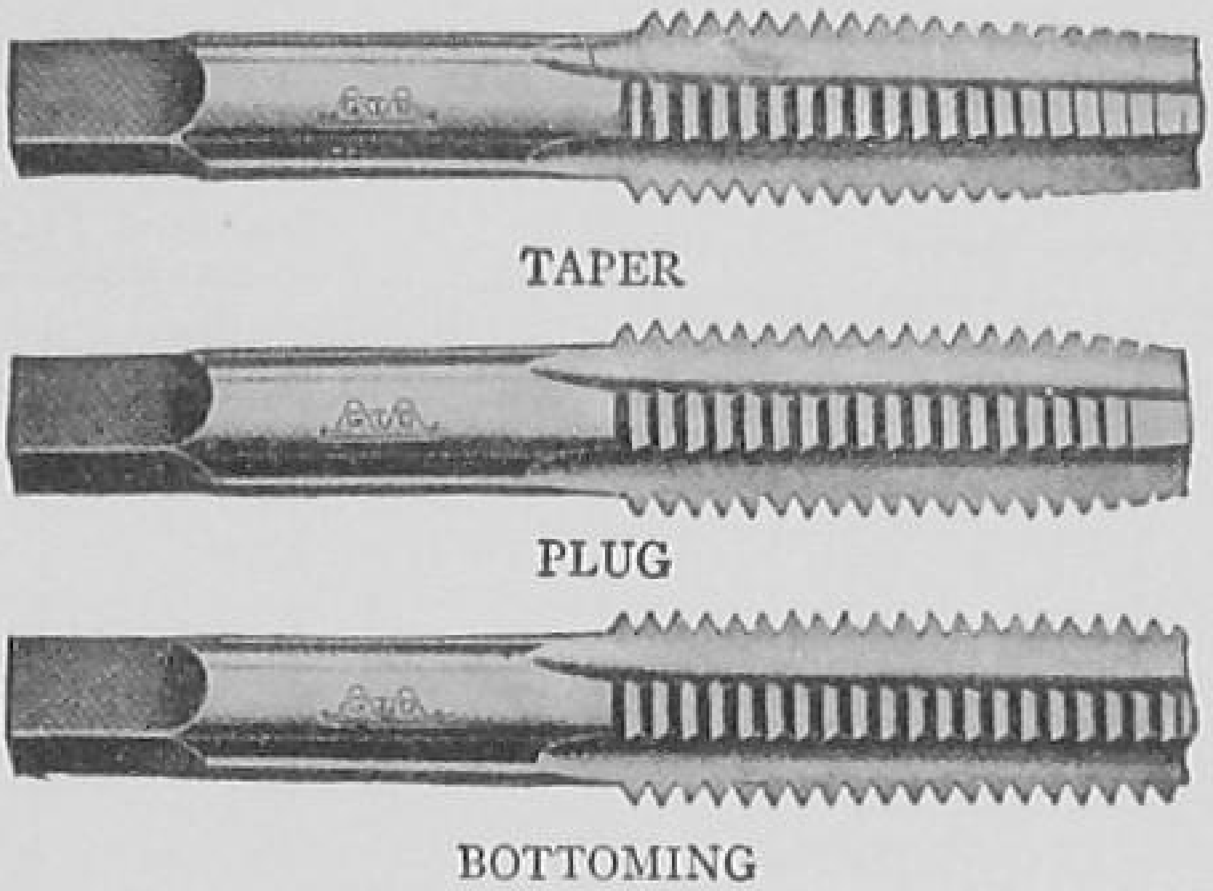


FIG. 23. Common taps.

A *die* is a tool for cutting external threads on a cylindrical piece of stock. The most common type of die is the round split die which can be adjusted for either a tight- or loose-fitting thread. The tool used to hold the die while turning it on work to be threaded is called a *die stock.*

FIG. 24. Die and die stock.

Thread sizes for taps and dies are divided into two general classifications. Sizes under ¼″ outside diameter are generally available in machine screw sizes which is a numbered size system designating the outside diameter of the bolt. To determine the decimal equivalent of a machine screw, multiply the size by 13 and add 60; thus you may convert a No. 5 machine screw to .125″ or ⅛″ diameter. Sizes over ¼″ are usually available in fractional sizes.

Threads are classified also as to their pitch or number of threads per

inch. There are two standard series of sizes used in metal work, the *National Fine* and the *National Coarse* series. The following table gives the various sizes in each series of threads and also the "tap hole" size or drill size to be used before tapping a thread:

TAP DRILL SIZES FOR COMMON SCREWS IN THE METALCRAFT SHOP

National Coarse Series		National Fine Series	
Nominal Size	Tap Drill Size	Nominal Size	Tap Drill Size
4 – 40	43	4 – 48	42
5 – 40	38	5 – 44	37
6 – 32	36	6 – 40	33
8 – 32	29	8 – 36	29
10 – 24	25	10 – 32	21
12 – 24	16	12 – 28	14
1/4 – 20	7	1/4 – 28	3
5/16 – 18	1/4	5/16 – 24	17/64
3/8 – 16	5/16	3/8 – 24	11/32
7/16 – 14	3/8	7/16 – 20	25/64
1/2 – 13	27/64	1/2 – 20	29/64

Stakes (Fig. 24a) are used in metalcraft work for various bending, forming, raising, and planishing operations. The stake has a square tang which may be held in a bench vise or a metal bench plate which is recessed into the stake bench for the purpose of holding stakes.

A common set of sheet metal stakes is a good set for bending metals into various shapes. Various others are available to conform with the contour of the work. Stakes should be kept free from dirt and with a mirror-like surface so that the metal being worked on them will not become marred by some imperfection in the surface of the stake.

The *anvil* is made of cast steel with an upper surface or face of hardened steel welded onto it. It has a conical horn with a flat section, which is soft, and its other end is rectangular with a round and a square hole through it. The hardened face is used for forging and general hammering, and the soft flat on the horn for cutting off either hot or cold stock with a chisel. The holes are used for bending purposes and for holding special tools. A good anvil, suitably mounted, is a very great help to the metalworker.

The standard *twist drill gage* is helpful in checking the size of a numbered twist drill. A table on the gage provides the user with the proper tap drill size for various machine screw taps.

The *American Standard wire gage* (Fig. 26) is used to gage the thickness of sheets, plates, and wire of nonferrous metals such as copper, brass, and aluminum. The B & S gage size is stamped on one side of the gage while the reverse side is marked with the decimal equivalent.

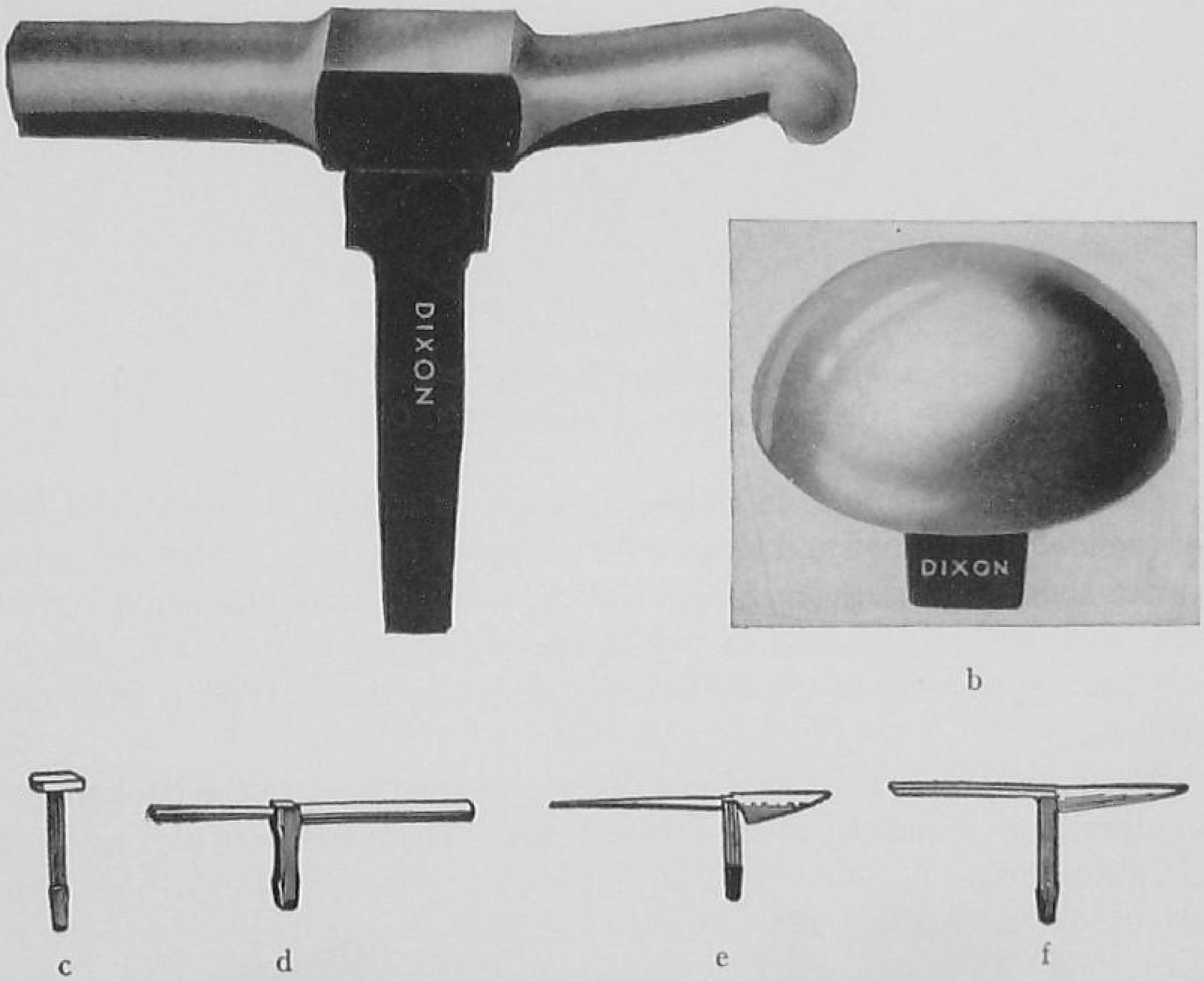


FIG. 24a. Stakes used in metalcraft.

a. "T" stake
b. Planishing stake
c. Coppersmith's stake
d. Conductor stake
e. Blowhorn stake
f. Beakhorn stake

FIG. 25. Anvil.

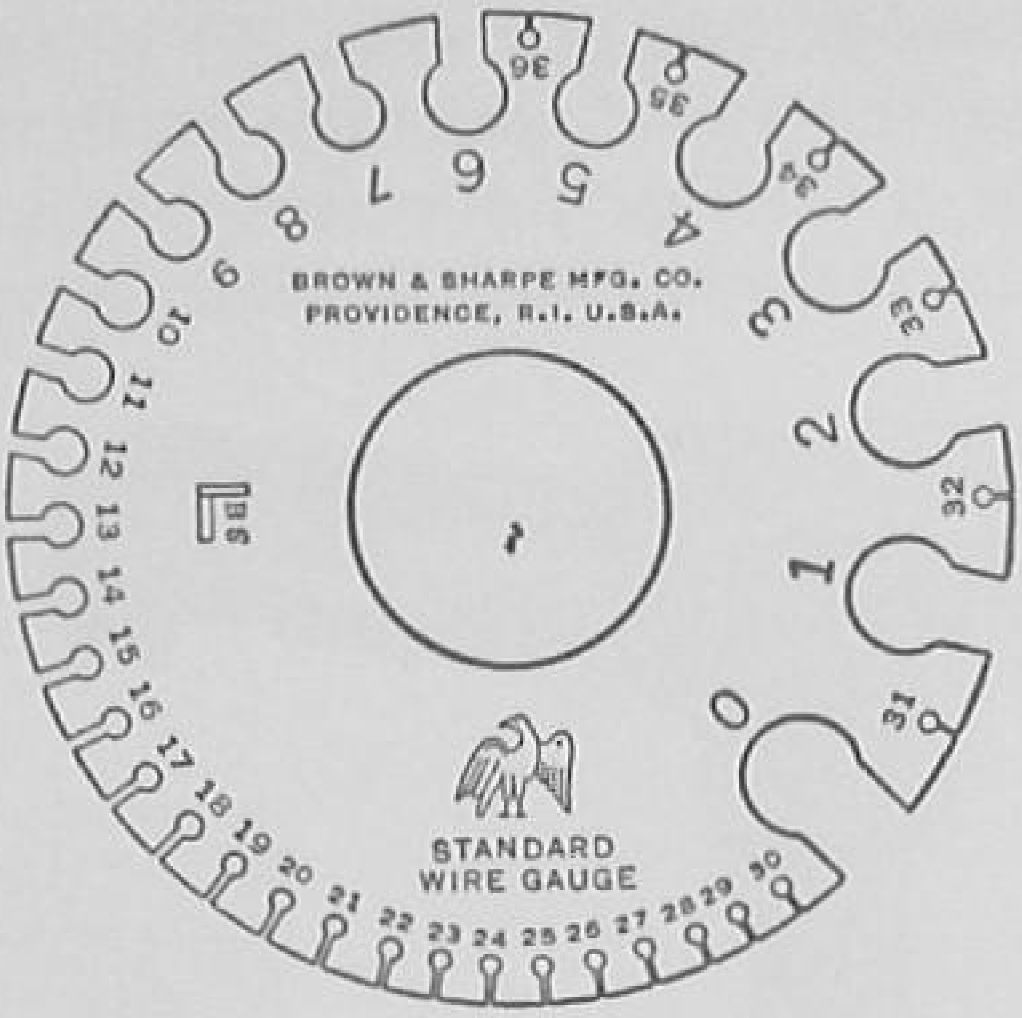
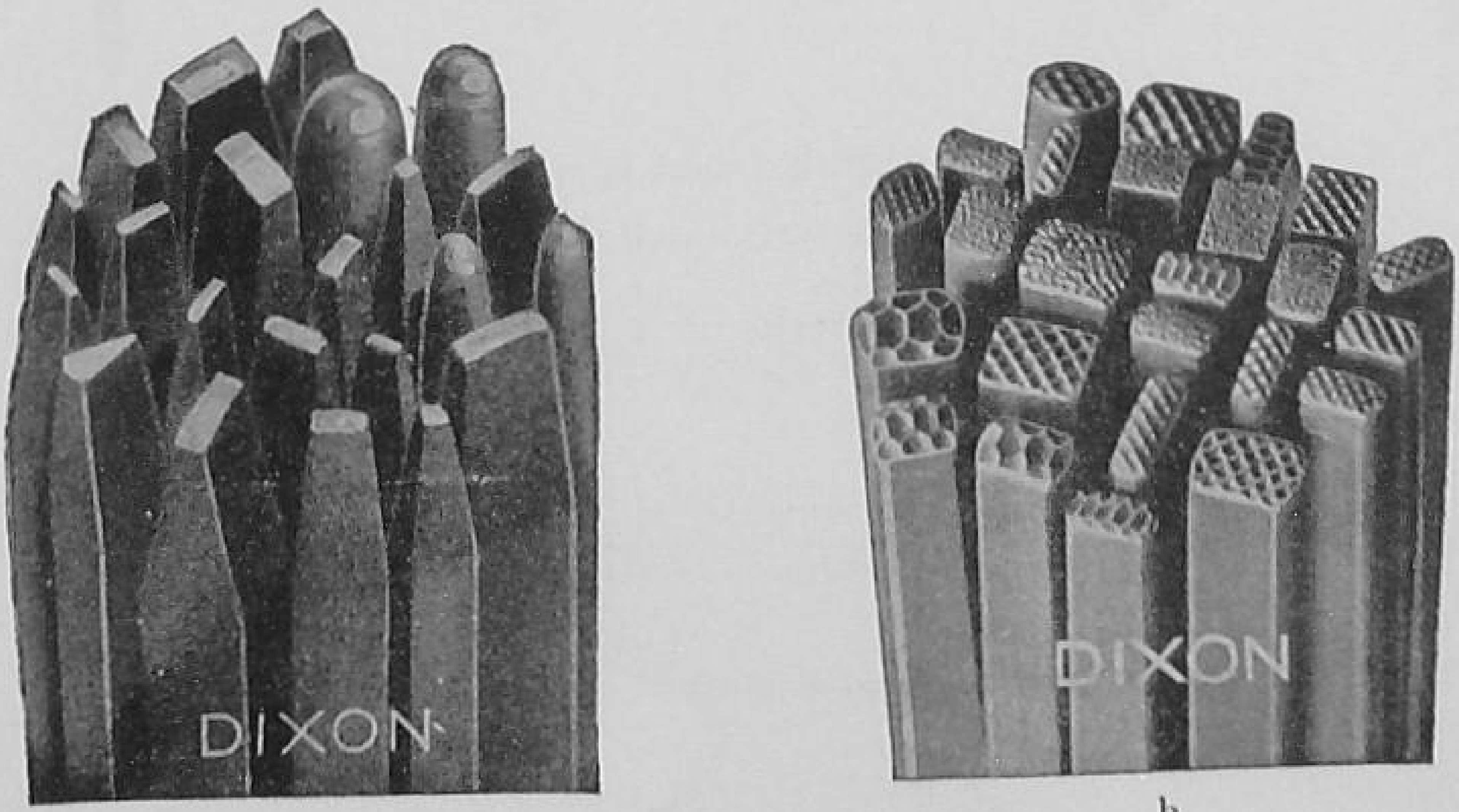


Fig. 26. American Standard wire-gage.
Courtesy Brown & Sharpe Mfg. Co.

Chasing tools are used in raising a design on copper or brass. The end of the tool is hardened and tempered and highly polished. There are many varied shapes and sizes for lining, raising, sinking, flattening, and planishing. Chasing tools are sold in sets of twelve, twenty-five or fifty. Handy sets can be made up to the individual's design in the craft shop from tool steel bars.

Matting tools are used to give a decorative treatment to the background in order to give contrast to the raised design. These tools are also made of



a b

Fig. 27. Chasing and matting tools.
a. Chasing tools b. Matting tools

tool steel and the ends are of various shapes in order that one may fit the tool into the contour of the work. The surface of the end of the tool is serrated to produce a stippled effect on the work. These tools also are available in sets of twelve, twenty-five or fifty.

Heating Equipment.

If gas is available in the metalcraft shop, a two- or three-burner gas furnace is handy for annealing metal projects and heating soldering irons. Provision should be made in the gas line for one or more *Bunsen burners* which are almost an essential when soldering pieces of metal. For heating large areas which are difficult to heat in the gas furnace, a *blow pipe* equipped with a regulating valve for gas and air is used. The air may be delivered to the torch by a *foot power blower* or, when used more often, the rotary power blower gives more efficient service.

There is an *alcohol blow torch* on the market for use in soldering in localities where no gas is available. This torch furnishes its own pressure and does not require a mouth blow pipe.

Tools Necessary for Doing Repoussé Work on Thin Sheet Metal.

For tooling a design on thin metals, the following tools are found most useful: a leather modeling tool for pressing the metal from the rear in order to raise the design and a *felt pad* to provide a backing for the metal as it is being modeled. The simplicity of the equipment used for this work makes it adaptable to almost any craft room without the necessity of obtaining expensive equipment.

Sheet Metal Machines.

There are a number of sheet metal machines which will be helpful in a metalcraft shop. These machines are not absolutely necessary in order to perform the work of a craftsman; however, they will be an asset to the shop if they are made available.

The *squaring shear* is a foot-powered machine used to cut straight and square edges on flat metal sheets. The capacity of the machine is limited to the length of the knife and the maximum thickness of the metal which it will safely cut. The maximum gage is usually marked on the machine near the knife.

The *slip form roller* is used to roll a flat sheet of metal into a cylindrical shape. The top roll may be raised for the removal of work after it is formed.

The *bar folder* is used to *hem* an edge on flat sheets of metal or for bending metal edges in preparation for wiring and seaming.

The *disc cutter* is a machine used to cut a circular disc from a square blank of metal. The machine has an adjustment for discs ranging from 2″ to the capacity of the machine. This machine is very handy in preparing circular discs for use in raising, forming, and spinning.

Power-Driven Machine Tools.

Grinder. The offhand grinder is a very important power tool for the metal shop. It may be obtained in the pedestal or the bench type with a wide variety of wheel sizes. Accessories are often available so that the grinder can be used for several other operations, such as buffing and sanding.

For the metalcraft shop, a bench grinder using 6″ to 8″ wheels is a practical size. In ordering a grinder, it is necessary to specify the type of grinding wheel, or to ask the manufacturer to supply a wheel that will be suitable for the job to be done.

The *drill press* is an important machine tool in the craft shop. This machine can be obtained in either a bench or floor model. The drill or bit is held in a *drill chuck* which should have a capacity of 0-½″.

Motorized Hand Tools.

These tools are very useful for small jobs of grinding, polishing, drilling, carving, and engraving. A motor is directly connected to a chuck, which holds a large variety of small rotary tools. The motor and tools are usually contained in a convenient carrying case.

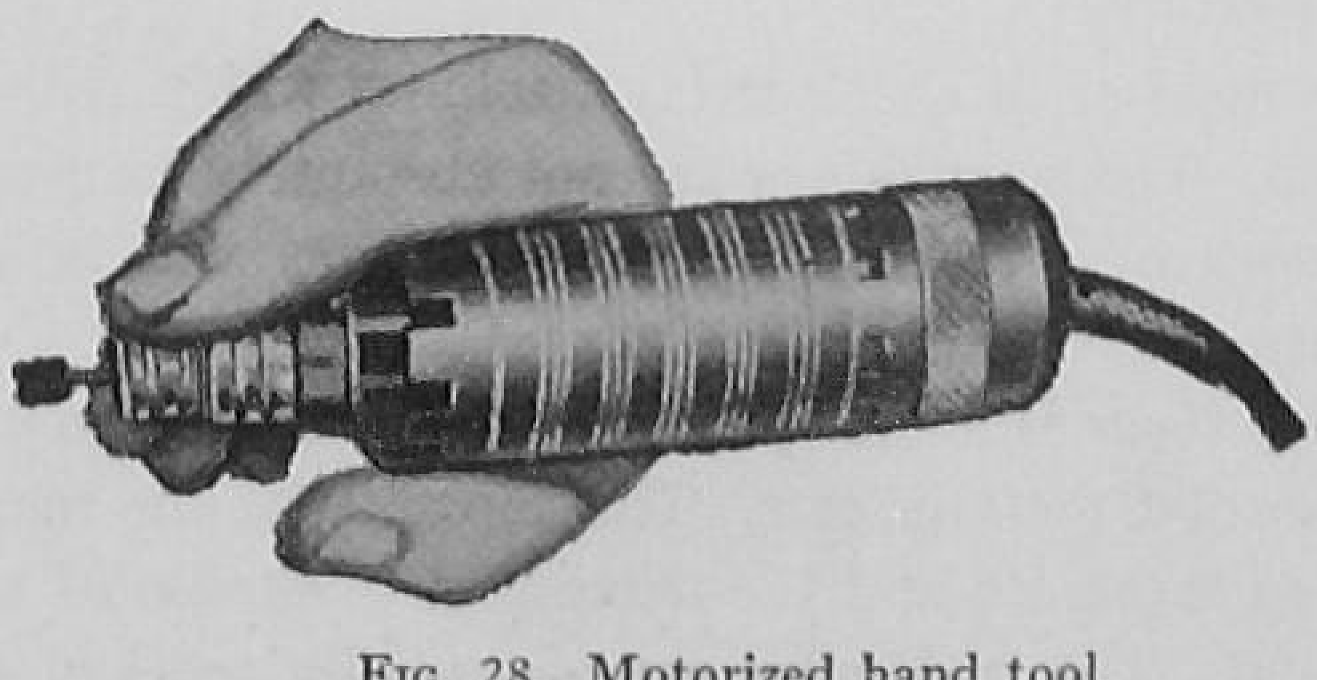


FIG. 28. Motorized hand tool.

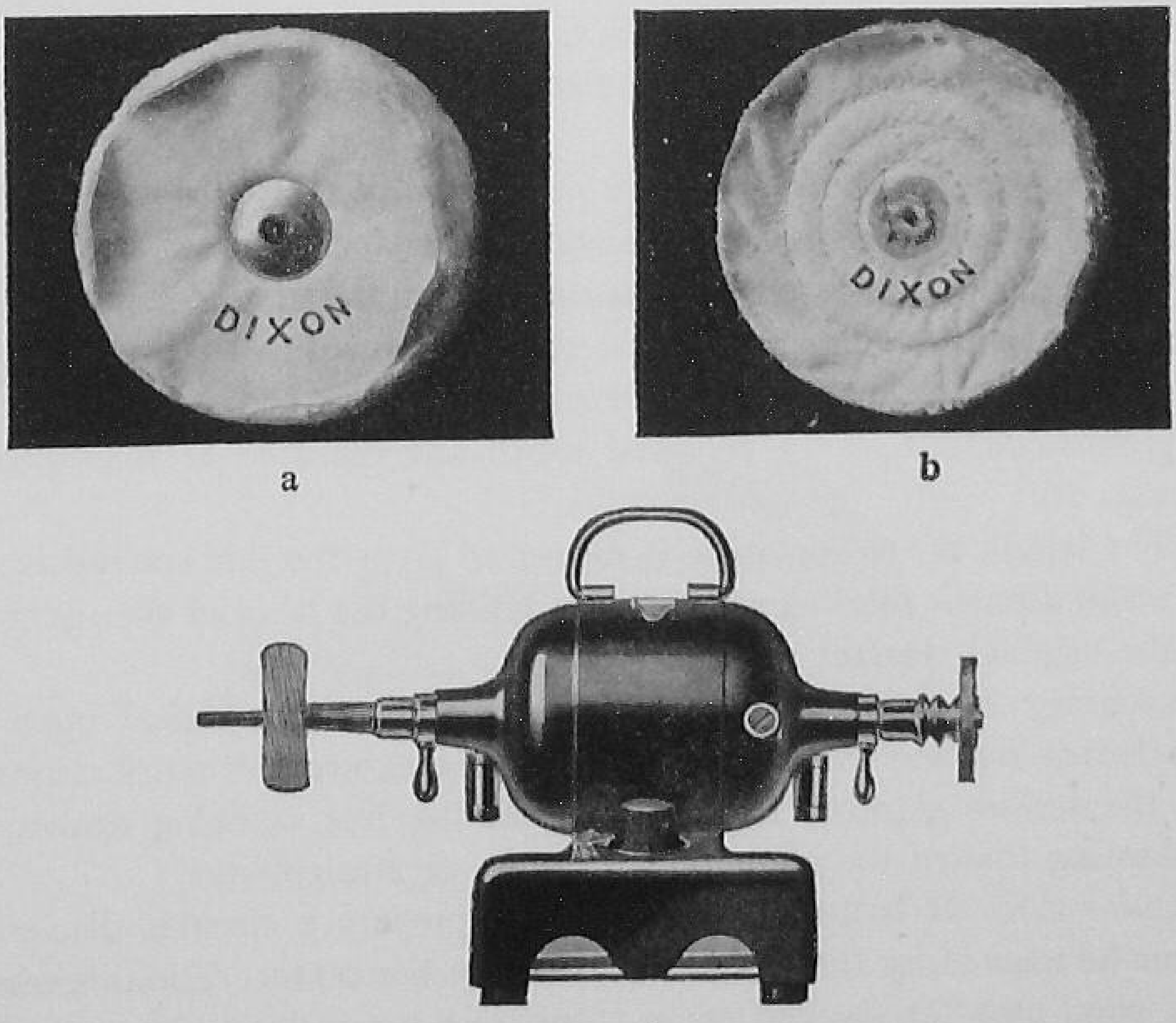
Probably the most important piece of power machine equipment in the craft shop is the *buffing machine.* This machine has a revolving spindle driven either directly by a motor or by being belted from a motor. The

spindle has two tapered ends which are threaded to take the various buffing wheels for polishing. The speed of a buffing spindle should be 1800 to 2000 rpm.

Buffing wheels for the buffing machine are made of several different materials in a variety of shapes. The most common wheels are: the *muslin buff*, both sewed and unsewed with a lead center; the *cotton flannel buff;* and the *felt buff*. All these buffs are used for the general purpose of "cutting" down the roughness of the surface and producing the final luster that finishes the work. These wheels are available in different diameters and shapes in order to obtain a finish on various shaped pieces.

Brass and steel *wire scratch brushes* produce a satin or brushed finish. *Bristle* brushes are used to polish special shapes which are not readily polished with the solid or buffing wheels. With the bristle brush, one may also obtain a satin finish.

A patented *rubber-abrasive composition wheel* is excellent for grinding away deep scratches on work. These wheels can also be used to remove ugly rust stains from tools.



a b

c

Fig. 29. Buffing equipment.

a. Loose cotton buff b. Heavy muslin c. Buffing lathe

Chapter III

OPERATIONS AND PROCESSES IN METALCRAFT

Making A Layout.

The first step, after one has decided on the project to be made in the metalcraft shop, is to make a layout on the metal to be used. It is a good plan, in most instances, to cut a piece of material to rough measurements allowing some material for waste and then make the layout. The following layout procedures for various shapes are described.

Square or Rectangular Blank.

Procedure:

1. Cut a piece slightly larger than the dimensions required.
2. Select one straight edge on the blank as the edge to be used for measuring and squaring.
3. Holding the machinist's square on this edge, scribe a line at right angles to this edge as near the end of the stock as possible.
4. The width of the rectangle is measured from the first edge and marked at two points. The marks are then connected with a scriber and straightedge. Narrow pieces may be easily marked, setting the machinist's square at the required width and marking as illustrated in Fig. 30.
5. The length of the rectangle is measured from the line scribed in step 3 and a line is marked at this point holding the head of the square on the original straight edge.

The accuracy of the rectangular piece depends a great deal upon the care taken in making the layout. Be sure to measure and mark carefully. Hold the scriber slanting in the direction the line is being drawn and also slanting toward the blade of the square or straightedge.

Circular disc. It is usually important to prepare a circular disc which will not be marred by the divider or punch in the center. For this reason, it is a good plan for the craftsman to prepare a centering piece on which he may place the divider point when marking the circumference. This

piece may be made by cutting a piece of copper 1″ x 1″. The diagonals are then drawn on this square and a center punch mark is made at their intersection.

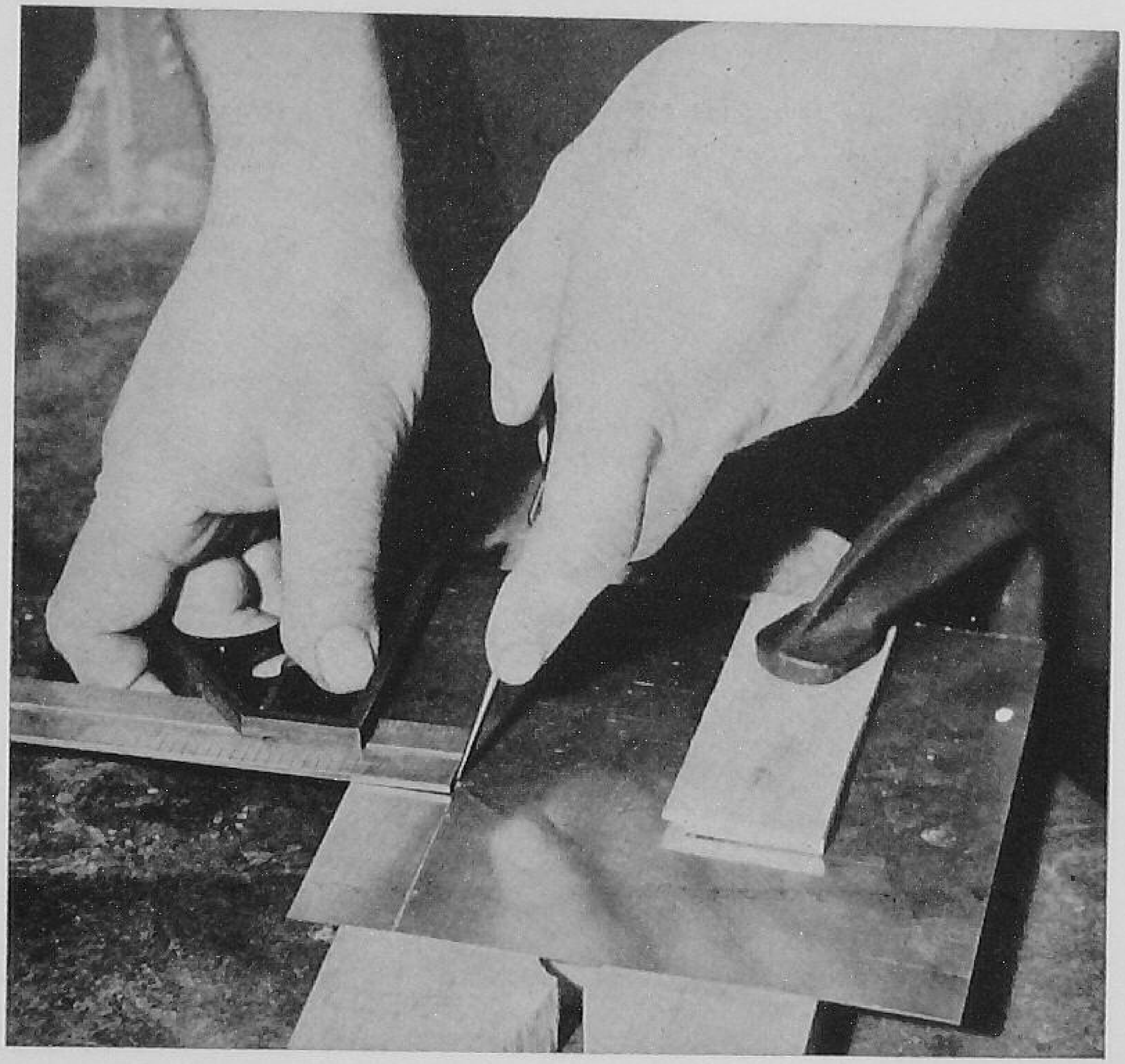


FIG. 30. Marking the width of a narrow piece using a machinist's square and scriber.

Procedure:

1. Prepare a square blank about ¼″ larger than the diameter of the desired circle.
2. With a lead pencil and straightedge, draw the diagonals of the square.
3. Place the centering piece described above on the blank so that its corners line up with the diagonals of the blank.
4. Open the dividers to the radius required and, with one leg of the dividers on the punch mark in the centering device, scribe the circle.

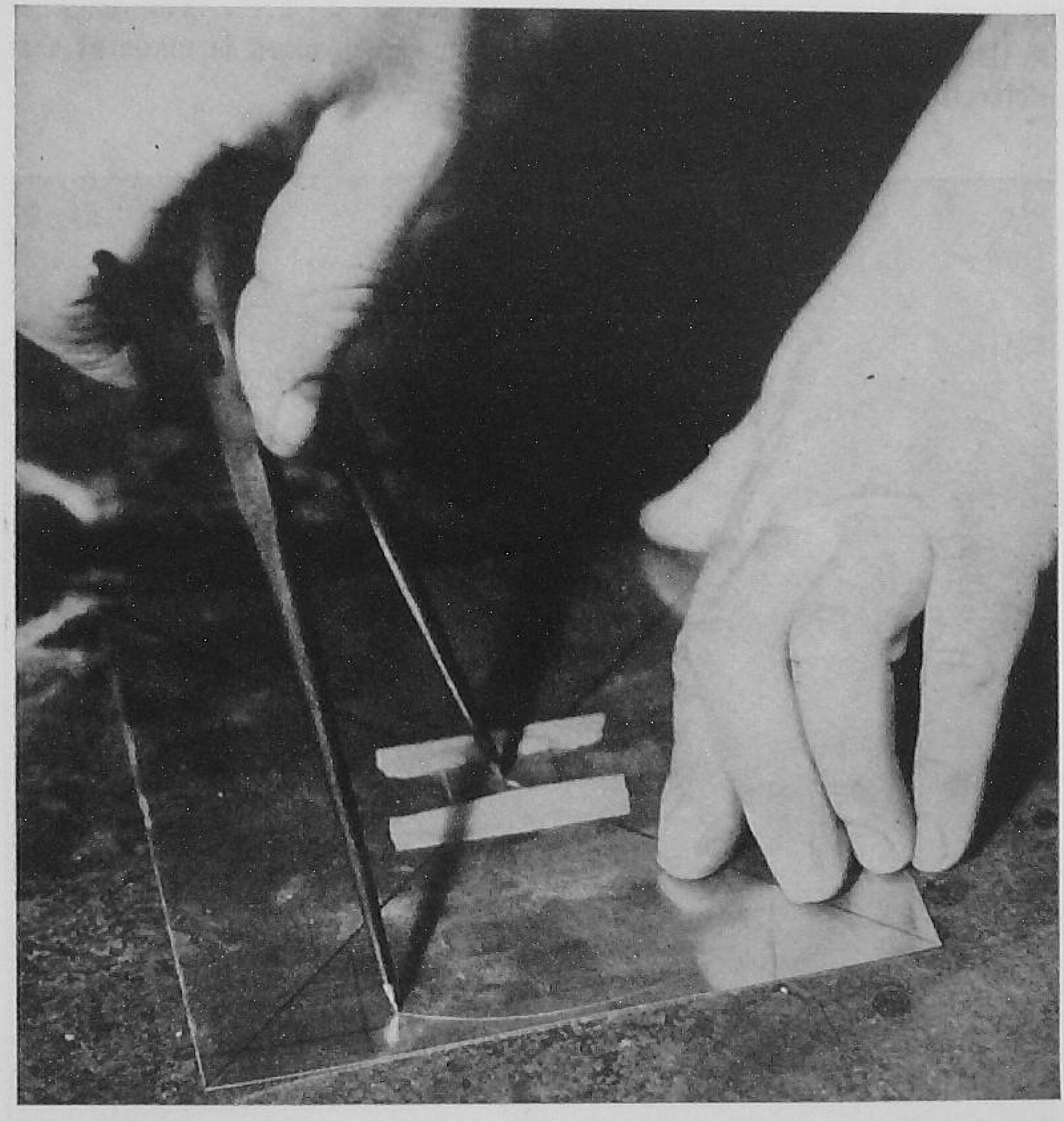


Fig. 31. Laying out a circular disc with dividers. (Notice the use of centering piece to eliminate center mark on work.)

Lean the dividers in the direction of rotation so that the point is pulled along its path as shown in Fig. 31. Hold the centering device securely with the left hand or fasten it to the disc blank with tape.

Laying Out an Irregular Contour Using a Template. An irregular contour may be layed out on a piece of metal by using a pattern or template. The following method will be found to be successful when but one object is to be marked out on the metal and is indispensable when laying out a series of duplicate parts. The template may be made of a stiff paper such as an *oak tag* or, for more permanence, from sheet metal.

Procedure:

1. Select the contour to be used or make a sketch of the shape on a piece of paper.
2. If the sketch is to be used full size, transfer it on a piece of *oak tag* and cut it out with scissors.
3. If it is necessary to enlarge or reduce a design, draw a series of squares over the design and also on the template material to the proper scale and draw the contour by using the squares. Cut out the template with scissors.
4. Clean the surface of the metal and mark the outline of the template on the metal, using a scriber or sharp pencil.

Cutting Metal.

Hack Saw. Bars of iron, tubes, and heavy sheets of metal are best cut by using the hack saw. The proper blade is dependent on the cross-sectional area of the piece being cut. A blade is selected which will permit at

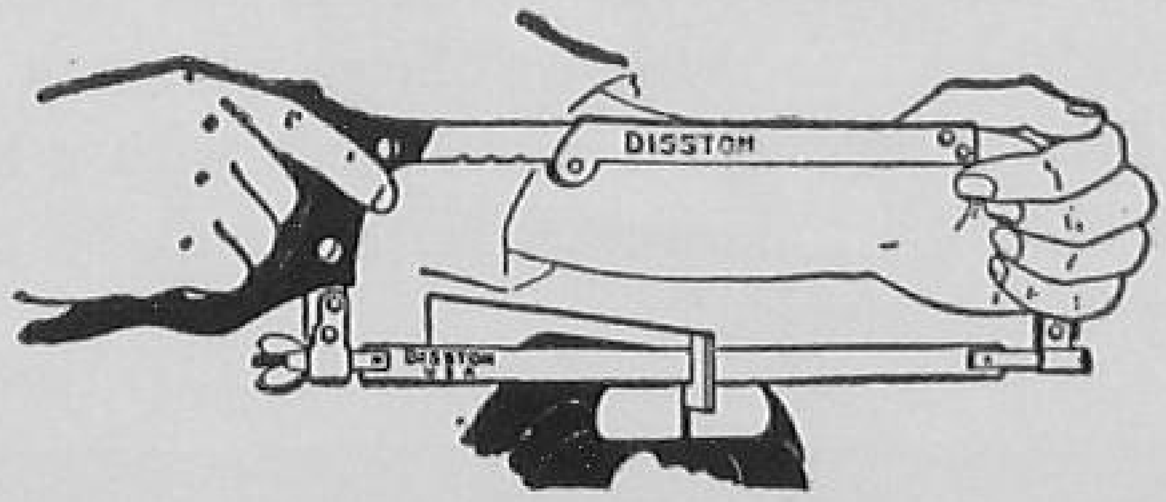


FIG. 32. Correct method of holding hack saw frame.

least three teeth to cut at the smallest section of the piece being sawed. A 32-tooth blade is best for sheets, tubing, and shapes with a small cross-sectional area. Larger bars will cut faster by using a 24- or 18-tooth blade. When the proper blade has been selected, place it in the hack saw frame with the teeth pointing away from the handle and adjust the tension of the blade fairly taut in order to prevent buckling. Place the work in a vise or secure it by clamping it to the bench. When held in the vise, best results will be obtained if the work is arranged so that the cut is close to the vise jaws.

Procedure:

1. Hold the saw with the handle in the right hand and the front end of the frame in the left.

2. Place the front end of the blade on the mark and start the cut with a forward stroke.
3. Release the pressure on the return stroke and repeat the process gradually increasing the pressure on succeeding forward strokes.

Using Tinner's Shears or Aircraft Snips. Straight cuts are made usually with the straight tinner's shears. Aircraft snips may be used to good advantage on heavy metal or for making straight or curved cuts.

Procedure:

1. Grasp the snips in the right hand and the metal in the left.
2. Open the blades and insert the sheet as far as possible into the jaws.
3. Place the cutting edge of the upper blade exactly on the line of the cut, and proceed as with ordinary scissors.
4. When approaching an inside corner, do not allow the end of the blades to extend beyond the corner line.

Circular discs are cut from square blanks. The straight shear or aircraft snips may be used. Cut on the line, holding the work in the left hand and removing the waste material in one piece. Inside and irregular curves are cut best by using the aircraft snips. A large hole may be cut in a metal sheet by first punching a hole in the waste stock with a hollow punch and then inserting the blade of the aircraft snips from the under side of the metal and cutting to the outline.

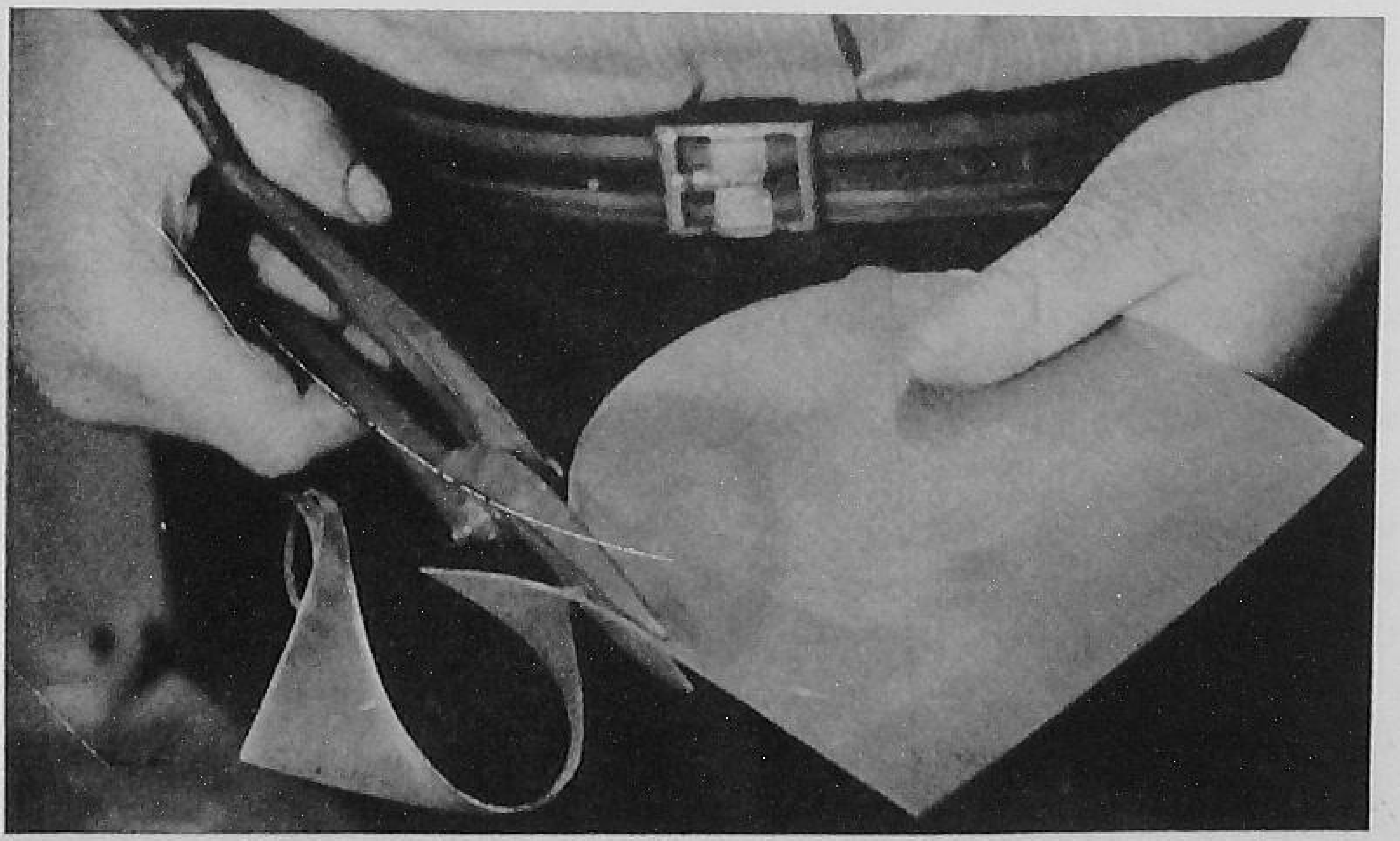


FIG. 33. Cutting a circular disc using straight tinner's shears.

Using a Cold Chisel. Grasp the chisel in the left hand and the hammer in the right. Do not grip them too tightly. The hammer should be held back toward the end of the handle to allow a free easy swing. Hit the head of the chisel a solid blow. The cutting edge should be kept on the line of cut. If the chisel is held too high, it will "dig" or cut too deep; if it is held too low, it will drift away from the line. Watch the cutting edge as you strike the blow. In this manner the cut can be directed accurately.

Place a supporting block beneath the work in the vise. This prevents the work from slipping downward in the vise jaws and keeps the line of cut parallel to the top surface of the vise.

Do not allow the head of the chisel to become mushroomed or spalled from excessive hammer blows. Grind it off occasionally. It is always wise to wear goggles when chiseling.

Lubricate the chisel occasionally with oil or soap when chipping wrought iron, brass or copper. When working on cast metals, it is good form to cut from each edge to the center, as corners are liable to break off below the finish line. For the same reason, ease up on the hammer blows as one cut approaches the other.

Using a Jeweler's Saw. A jeweler's saw is used to cut irregular curves in sheet metals and especially for piercing intricate designs in projects made of the various art metals. The work is held over a wooden bench pin or block of wood having a V cut on its surface. The best blade for most work will range from No. 2/0 to No. 2.

Procedure:

1. Place the wooden bench pin in a vise, or clamp it to the bench top with a "C" clamp so that the V extends over the edge of the bench.
2. Prepare a paper pattern of the design to be used and cement the paper to the metal using rubber or paper cement.
3. If the work is to be pierced, a hole must be drilled in the waste stock for the purpose of inserting the saw blade.
4. Insert the blade in the saw frame so that the teeth point toward the handle. Adjust the frame so that the blade is taut.
5. Assume a position at such a height that the forearm, when held horizontal, is in the plane of the bench pin.
6. The cut is started on a downward stroke, slanting the saw slightly toward the direction of the desired cut.
7. After the cut has been started, the saw is held vertically and may be lubricated by rubbing a bit of beeswax on the blade.

Especial care must be taken, when working around a small radius, to keep the saw in motion and to hold it so that the blade is vertical. Any pinching of the saw blade in its kerf may break the blade.

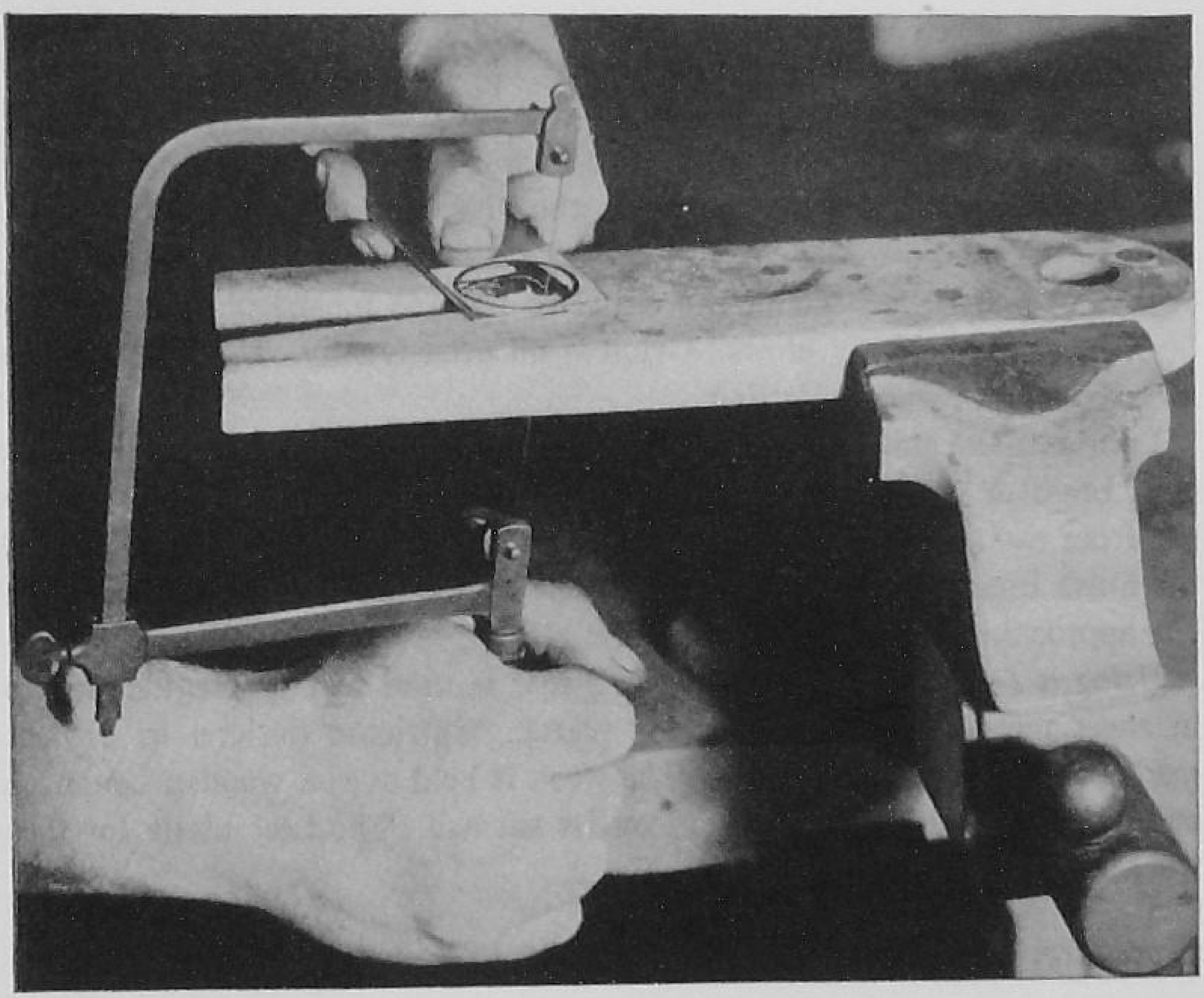


FIG. 34. Sawing with a jeweler's saw.

Cutting Stock with the Squaring Shear. The squaring shear may be used to cut straight, square edges on sheet stock. There is a limit to the gage and width of metal that can be cut with the squaring shear. When the shear is new, there is a plate fastened to the machine giving this information. Before cutting, a layout should be made in pencil on the stock in such a way as to insure the best use of the stock with the least waste.

Procedure:

1. Place the longest straight edge of the stock to be cut against the guide fence of the machine and by stepping on the treadle, trim about $\frac{1}{16}''$ off the end in order to insure a square end.
2. Make a measurement of width required and cut off stock.

3. Holding the longest edge of the piece of stock against the guide fence, cut the stock to length. *Caution*: Take care not to have fingers near the cutting knife. Be sure no one is standing near the machine with his foot under the treadle.

Cutting a Disc on the Circular Shear.

Procedure:

1. Prepare a square blank at least 3⁄16″ larger in diameter than the size of the disc required.
2. Set the machine, by the gage, for the correct diameter required.
3. Start the cut near the corner of the square, cutting about 1⁄16″ in from the edge and guide the blank until it is centered under the clamping pads.
4. Clamp the blank in position and cut the disc.
5. If the disc is required to be cut to exacting measurements, set the machine and cut a disc of black iron to determine the size and adjust the machine if necessary.

Filing.

Filing a Flat Surface (cross filing). The size of the file that is to be used for a job depends on the surface which is to be filed. A fairly large flat surface requires a 10″ or 12″ file whereas a smaller surface is usually filed with a 6″ or 8″ file. If a good amount of material is to be removed, select a 10″ flat file with a bastard cut. In order to file properly, a handle should be secured to the tang of the file.

Procedure:

1. Secure the work in the vise so that the surface to be filed is held horizontal.
2. Grasp the handle of the file in the right hand and the toe of the file in the left.
3. Hold the file obliquely to the work and file by pushing the file across the work and, at the same time, along the work.
4. Release the pressure on the return stroke and repeat the procedure, taking care not to rock the file over the surface.
5. From time to time, clean the metal particles from the file by using a *file card*.

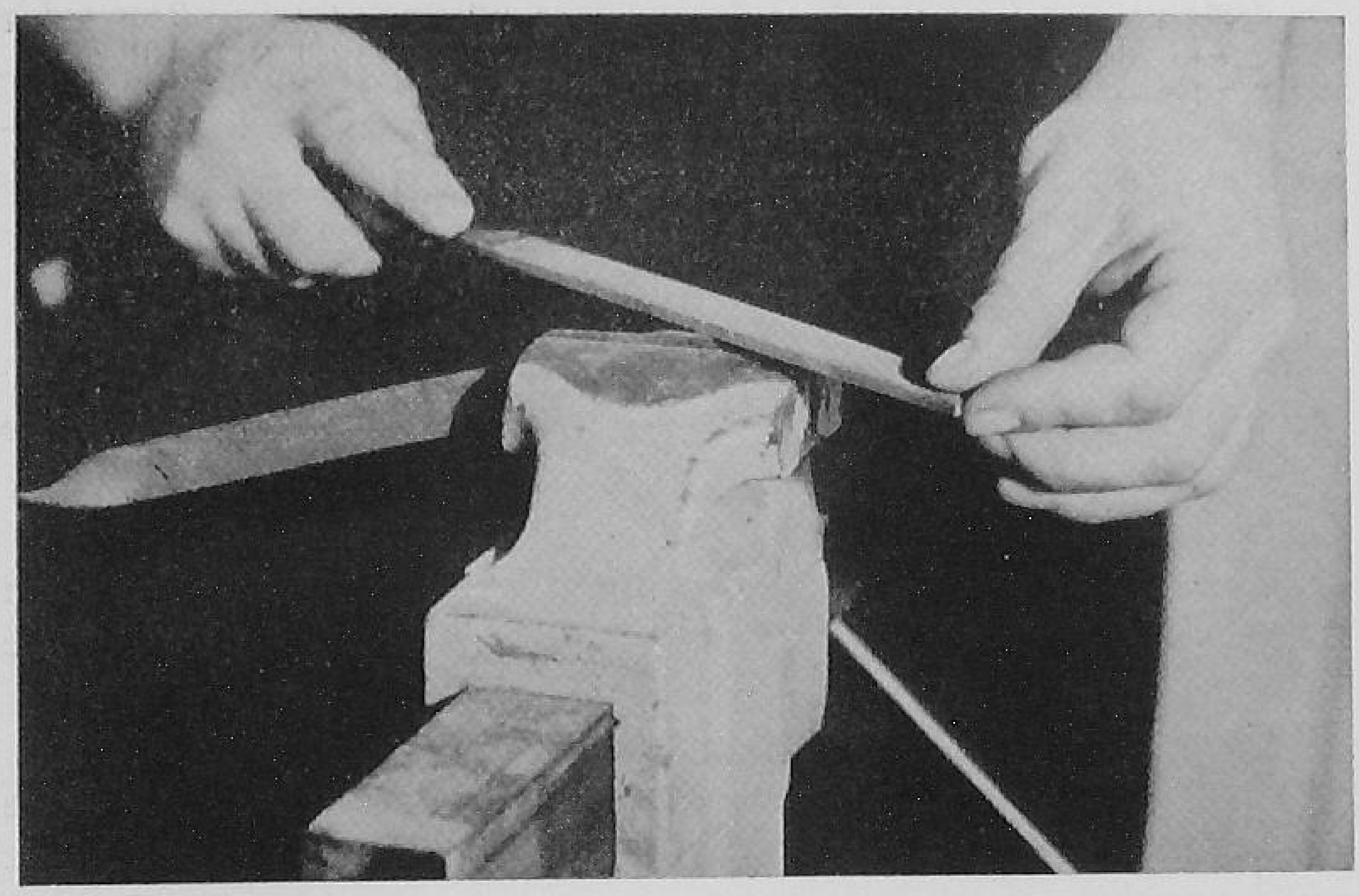


FIG. 36. Cross-filing a piece of metal held in a vise.

Draw Filing. In order to obtain a better finish before polishing, it is a good plan to draw-file the surface. This operation is done with a mill file of about the same length as is used in the above procedure. The file is held in both hands, as illustrated in Fig. 36, and drawn over the work to "true up" the surface and remove any marks left in the work from cross filing.

Miscellaneous Filing Work. The thin edge of a plate or disc of metal can be filed by holding it over the edge of the bench and by filing the edge with a mill file in the direction of the metal. A 6″ or 8″ half-round, second-cut file is handy for filing into the corner of an edge design, holding the metal against a hard wood block held in the vise. Small, intricate work may be filed with jeweler's needle files, selecting the file that most nearly fits the contour of the work. Tool steel should be annealed before filing since the hard surface may destroy the cutting edge of the file.

Care of Files. Files should be stored in a rack which is so designed as to permit them to be removed and replaced without touching any metal surface. Care must be taken, especially with small files of thin cross section, to prevent breakage from applying too much pressure. A file, as well as being hard, is brittle and will not bend to any extent without breaking.

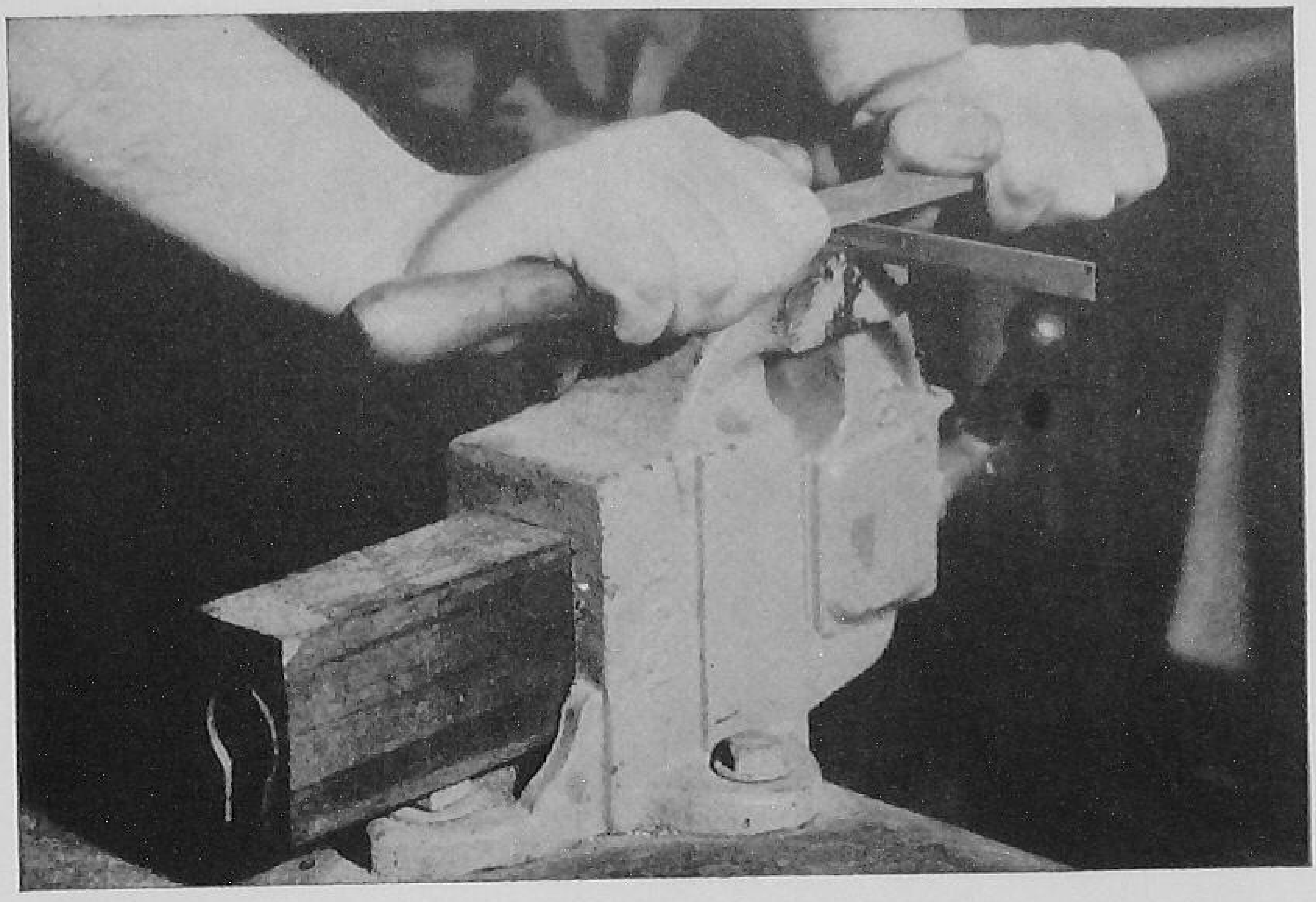


FIG. 35. Draw-filing.

Drilling.

A hole is drilled in metal with a twist drill. This drill or bit is held in the chuck of a *hand drill* or *drill press,* depending on whether the hole is to be drilled by power or by hand. Before the hole is drilled in metal, its center must be located on the metal and the hole is then marked with a center punch. The mark made by the center punch will aid in starting the drill in the correct location.

Procedure used in drilling a hole with a hand drill:

1. Locate the center of the hole to be drilled.
2. Center-punch this point using a hammer and center punch.
3. Select the proper size drill for the job and place it in the hand drill.
4. Secure the work to the bench in a way that will prevent a hole from being drilled in the bench.
5. With the left hand on the handle and the right hand on the crank, place the drill point on the punch mark and adjust the position of the hand drill so that the drill is at right angles to the surface being drilled.

6. With the right hand, turn the crank clockwise and apply a bit of pressure on the drill. (Small drills must be turned rapidly and require very little pressure.)
7. Care must be taken when the drill breaks through the bottom of the hole. Pressure must be released at this point and the drill is eased through the hole gently.

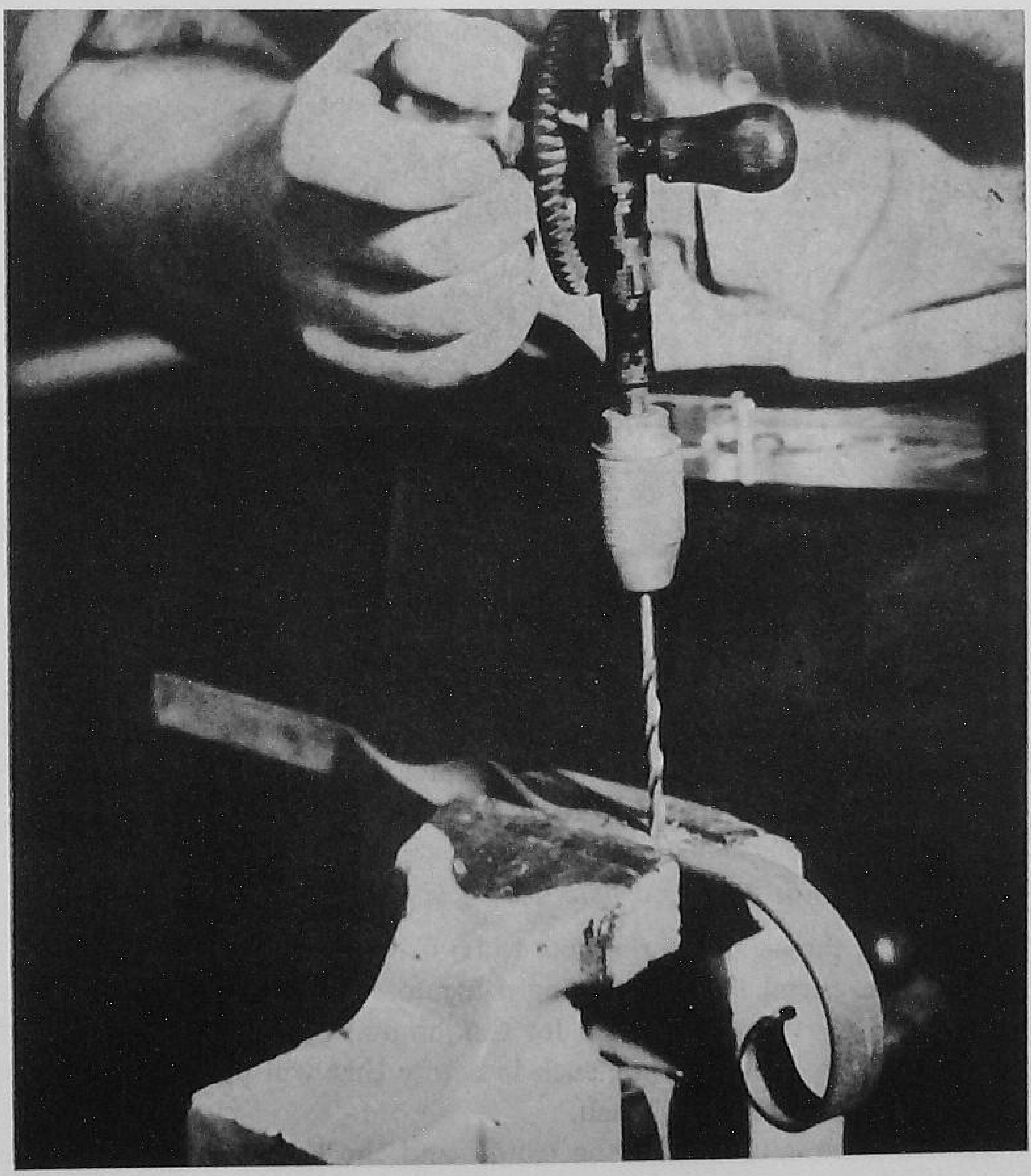


FIG. 37. Drilling a hole in metal using a hand drill.

Drilling Data

Material	*Coolant*	*Speed*
Tool steel	Lard Oil	Slow
Mild Steel	Lard Oil	Medium
Brass	Dry or Kerosene	Fast
Nickel	Dry or Kerosene	Fast
Copper	Dry or Kerosene	Fast
Aluminum	Dry or Kerosene	Very fast
Pewter	Dry or Kerosene	Fast
Wood	Dry	Very fast

Grinding.

An *off-hand grinder* is a must in a metal shop. It offers a quick method of sharpening tools such as drills, punches, cold chisels, etc. It also can be used to shape the ends of pieces of band iron before they are bent into a scroll. The work to be ground is held against the wheel at the desired position, and it is supported in the hand or on the rest at a point slightly above the axis of the wheel. The tool rest should be adjusted so that it is about 1/16″ away from the face of the wheel. This will prevent pieces from becoming wedged between the stone and the rest.

The grinding operation, like most other skills, must be practiced before good results can be obtained. The piece being ground is usually hardened steel and must not be heated to the point where its temper will be affected. A light firm pressure with repeated cooling in water is necessary. Never grind soft materials such as wood, lead, or brass on the grinder, because these materials will load up or glaze the wheel and interfere with normal grinding action. The wheel must be periodically dressed with an abrasive stick or other commercial dresser to insure smooth running and efficient grinding.

Bending, Twisting, and Folding Metal.

Most of the bending, twisting, and folding of metal in the craft shop is done while the metal is cold. Bands of metal that are to be bent to form scrolls for various parts of a project are usually formed at the end in order to produce a pleasing finale. Various shapes as illustrated may be used. The flared shape (Fig. 39B) requires hammering which will harden the

When drilling a hole more than $\frac{3}{16}''$ diameter, it is good practice to use a power drill. The following rules should be observed:

1. Use a correctly sharpened drill, tightly clamped in the chuck.
2. Do not hold the piece being drilled by hand. Clamp it to the table of the drill press, hold it in a vise, or for small pieces, use a pair of pliers.
3. Make the drill *cut*. It is constructed to take a good shaving at both of its cutting lips. Too little or too much pressure will ruin the drill, and probably the piece also.
4. Use the proper speed.
5. Keep the drill cool with a suitable coolant.
6. Do not drill into pieces that will bend while drilling. This will almost certainly break the drill.
7. Always center-punch the hole position carefully, and if accuracy in positioning is desired, draw a circle with the dividers about one-half the diameter of the drill. As the drill is started in the center-punch mark, this circle will help in determining if the drill is following the mark. If it is found that the drill is not following the center-punch mark, then by tipping the piece slightly or by recenter-punching, the drill point may be made to shift its location in the direction indicated by the circle. For large holes, two or more concentric circles may be used.
8. Test the piece to be drilled with an old file to see if it is hard. If the piece cannot be easily filed, it will ruin the drill.

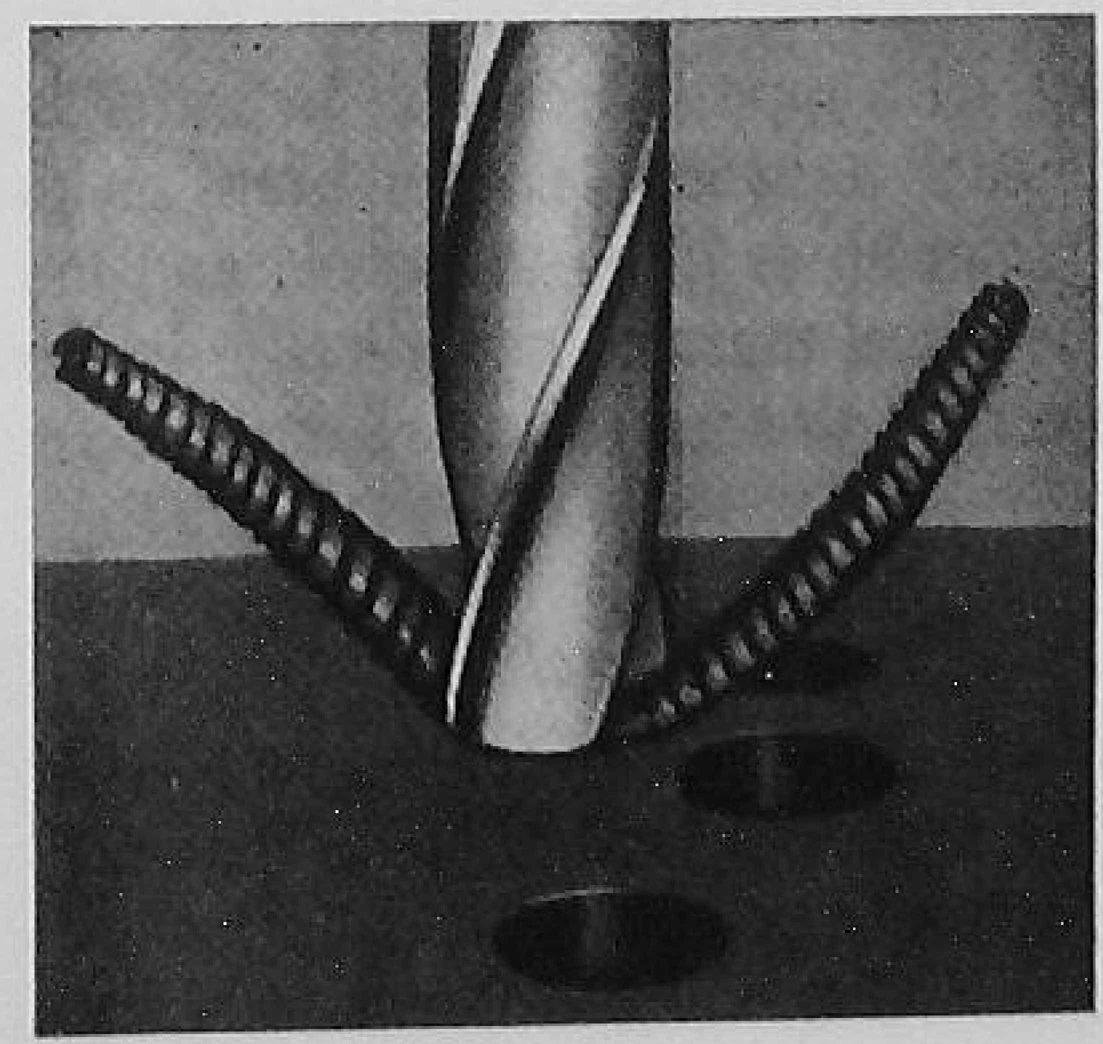


Fig. 38. A drill cutting correctly.

metal. The ends should then be annealed before atempting to bend the scroll. Some of the above shapes can be formed with a saw and others may be ground on the grindstone or shaped by filing.

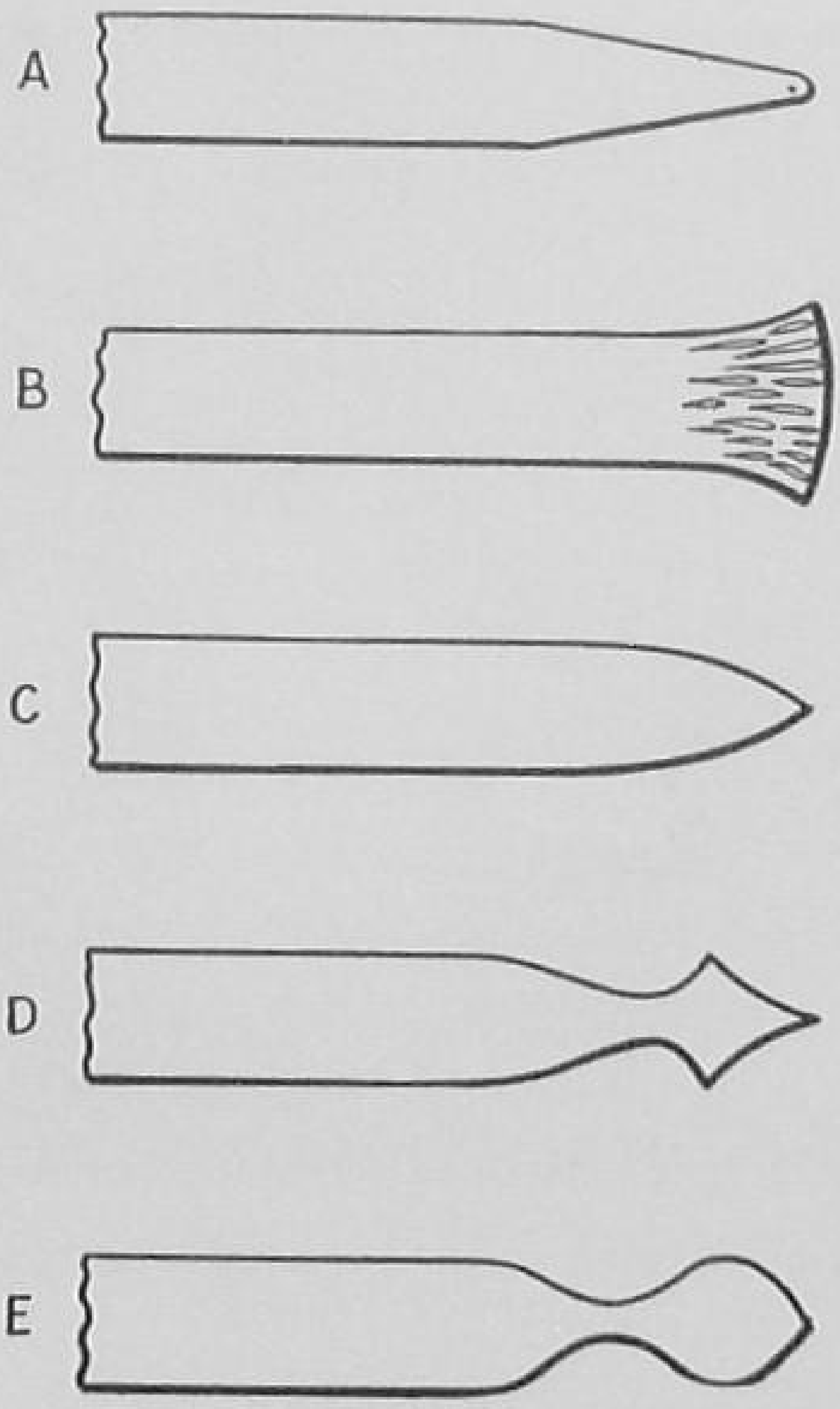


FIG. 39. Various shaped ends for metal bands.

Bending a Scroll. Straps or bands of metal are often required to be bent into circular or irregular curves called *scrolls*. These curves are most easily bent in a jig called a *bending jig*. The theory of this shaping is that a regular curve is made by making a series of uniform bends, in the band, close together. The closer these bends are made to each other, the smaller the radius of the curve. Much care must be taken to continually compare the work with a full-size layout of the curve so that corrections may be made as soon as the curve does not match.

Procedure:

1. Make the full-size layout of the curve required on a piece of paper.
2. Set a pair of dividers at a convenient measurement such as 1″, and step-off the length of the piece with dividers.

3. Cut the stock to length and form the ends as suggested in Fig. 40.
4. Place the bending jig in the vise and adjust it for the thickness of the stock.

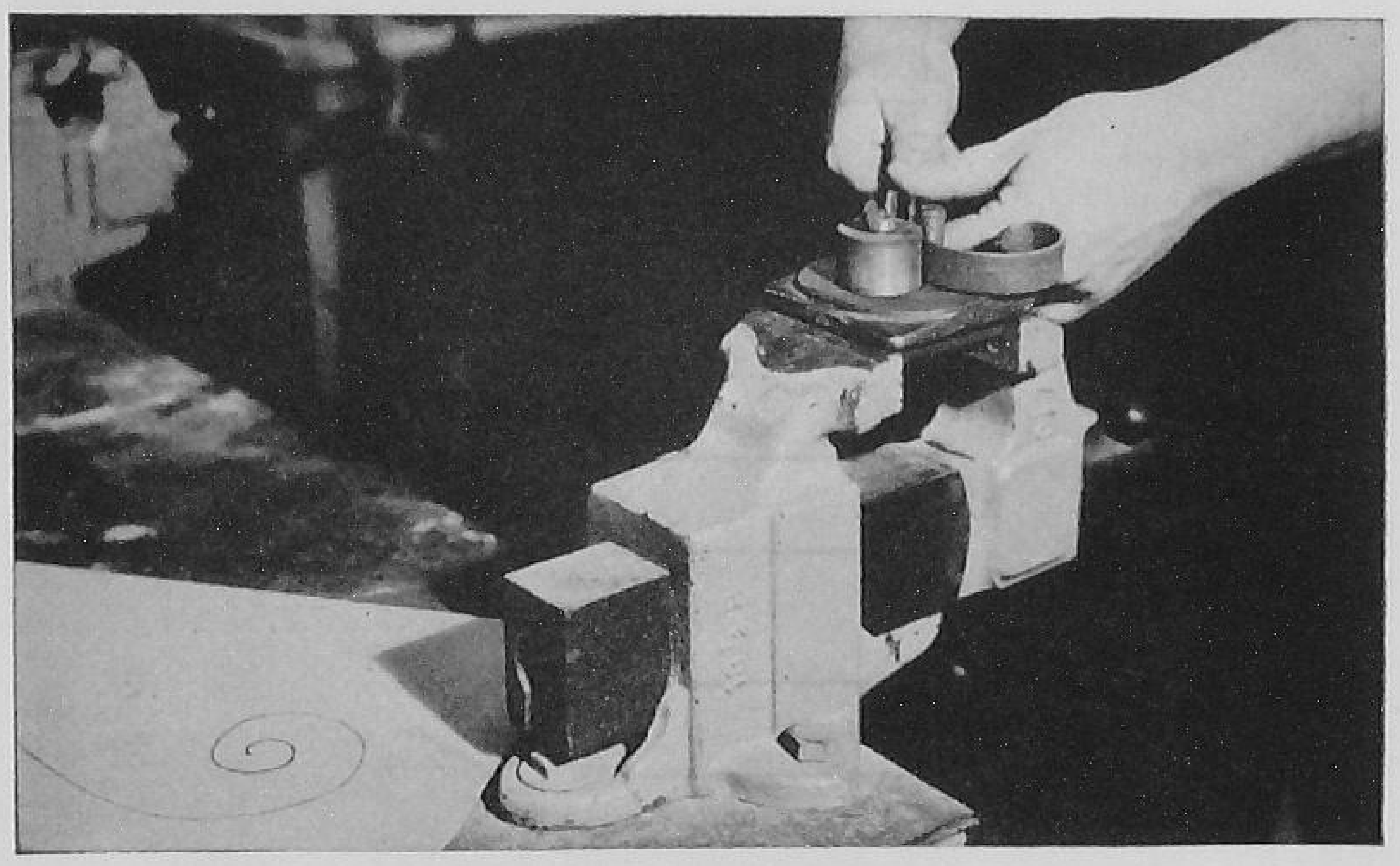


FIG. 40. Bending a scroll using the bending jig.

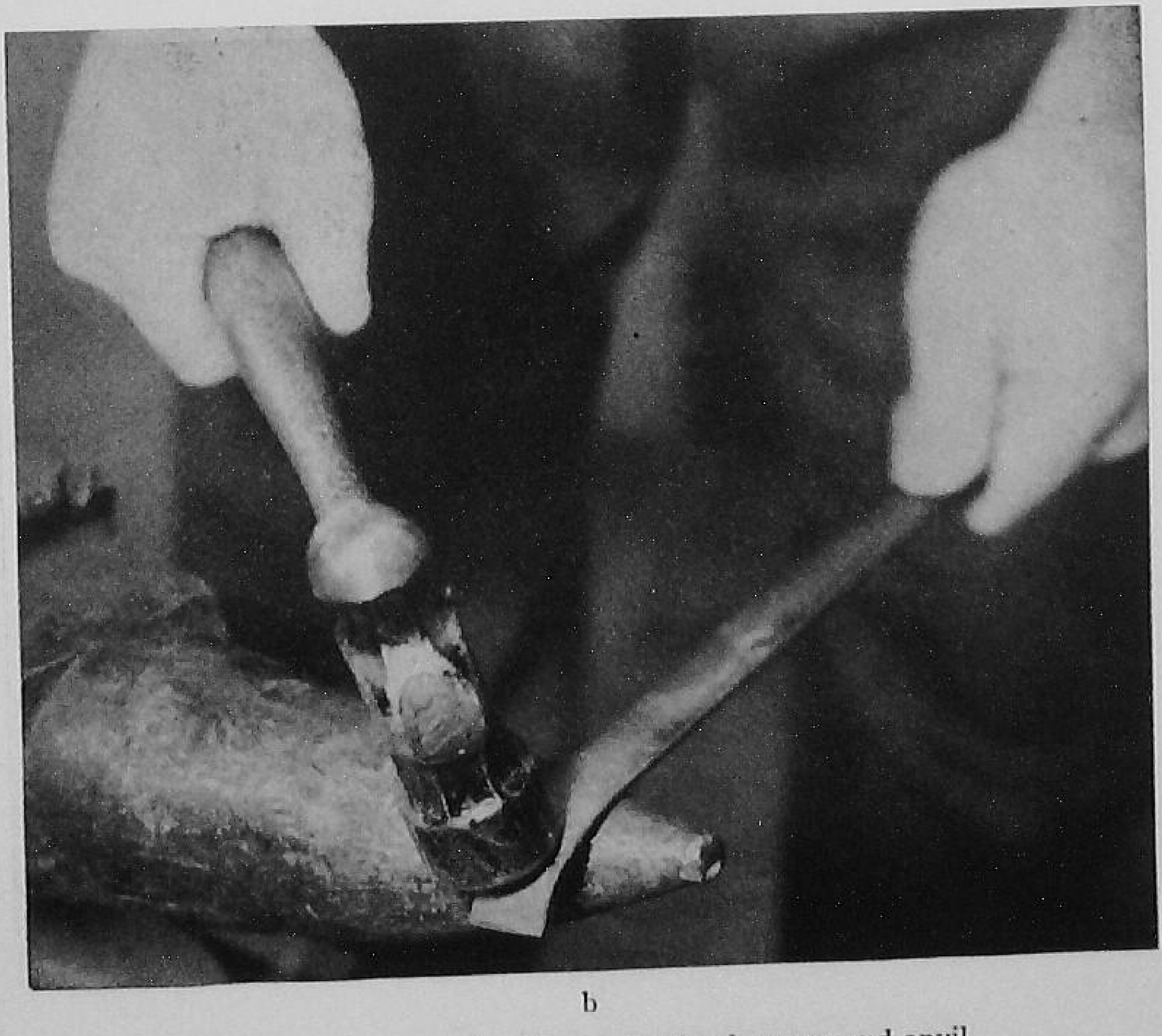
5. Bend the scroll by starting at one end and bending slightly, then advancing the work slightly. Repeat this bending operation, making successive bends, continuing toward the center of the piece.
6. From time to time, compare the work with the curve required.
7. If there is to be a curve at each end, work from each end toward the center.

Forming a Scroll on Heavier Metal. Heavier metals bend with more difficulty and therefore require heating in order to produce the proper curves. The principal of making a series of short bends on the work and comparing the work with the full-sized layout of the curve is the same as that in the above procedure.

Procedure:

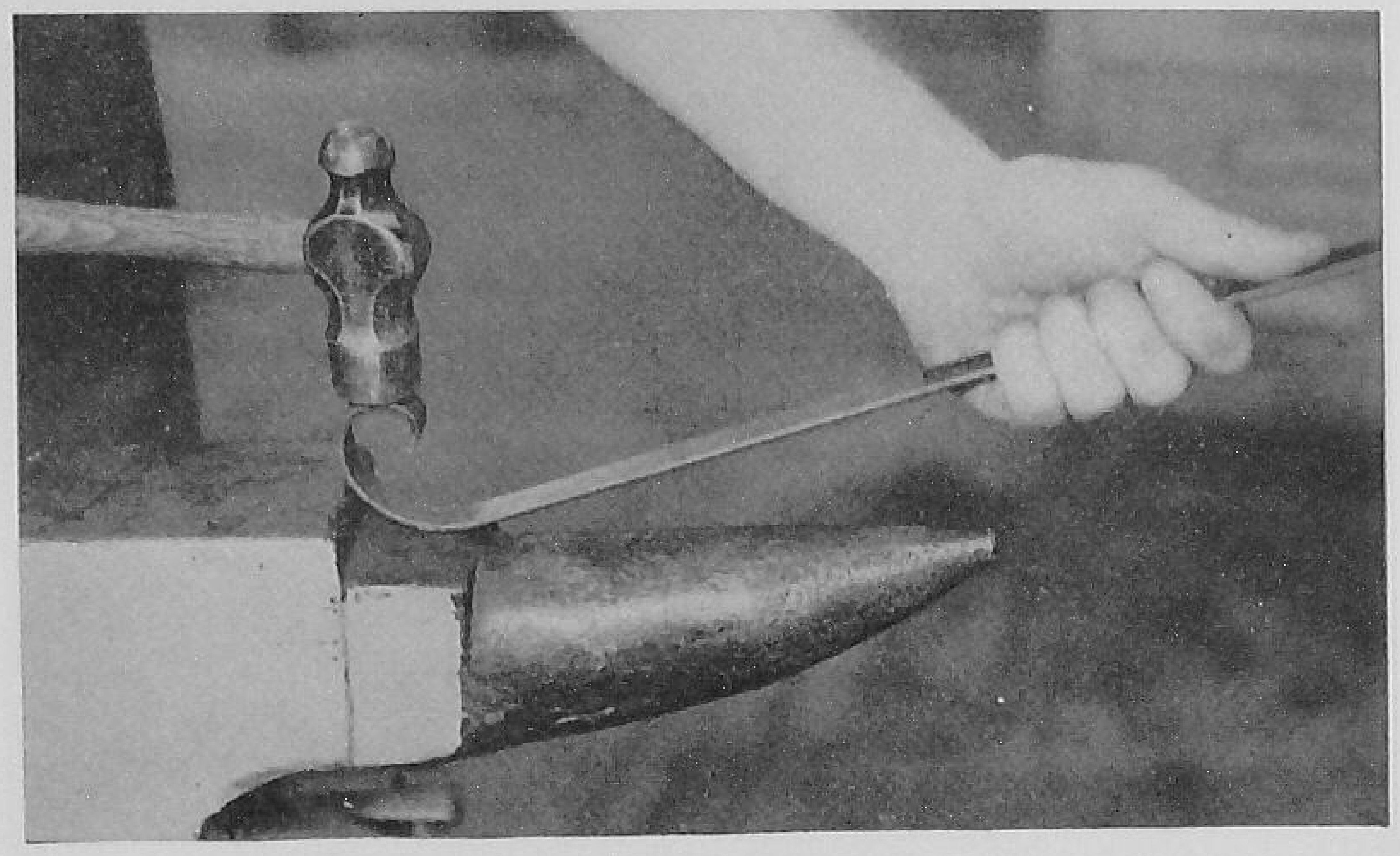
1. Heat the metal in the furnace to a bright red and lay it on the anvil over the horn; form the end of the scroll by striking the work with the hammer at an angle as shown in Fig. 41a.

a



b

FIG. 41. Starting to bend a scroll using hammer and anvil.



a

b

Fig. 42. Completing the scroll using hammer and anvil.

2. Feed the work over the horn of the anvil striking it at the same angle near the horn (41b).
3. After the scroll has been started, the work is reheated and placed on the anvil with the curve up, and the end of the curve is closed using light, well-directed blows of the hammer (42a).
4. The scroll may then be completed by bending over the horn of the anvil (42b).

Making a Twist in a Metal Bar or Band. A pleasing effect may be obtained on band metal work by twisting either a section or the entire piece

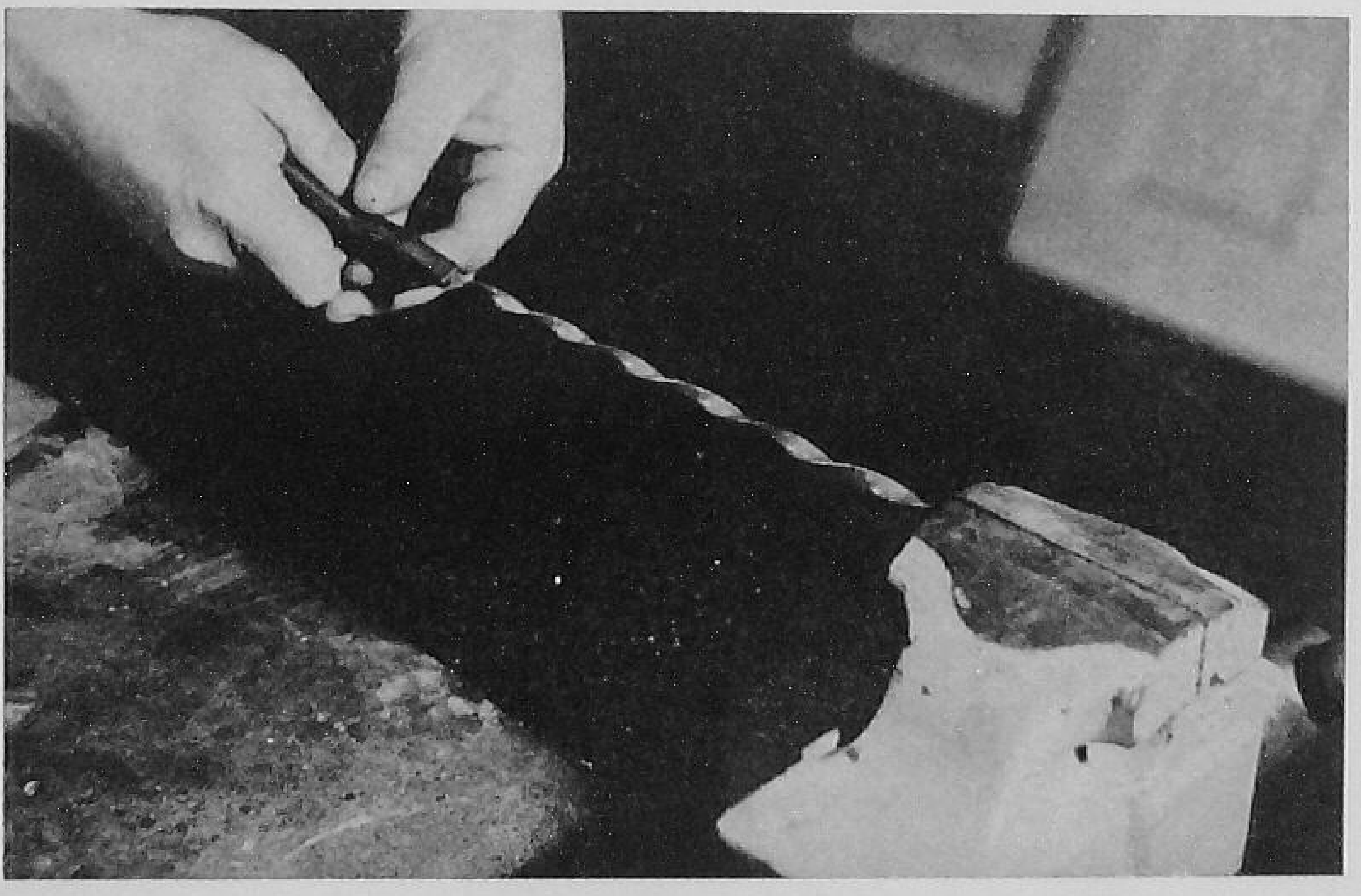


FIG. 43. Twisting a band of thin metal with a pair of pliers.

of work. Bands and squares of any thickness may be twisted successfully. Thin bands of copper, brass or silver can be twisted by holding one end in a machinist's vise and grasping the other end with a pair of square-nose pliers. Holding the metal taut, the pliers are turned until the desired twist is obtained (Fig. 43). A heavier piece of metal may be twisted as follows:

1. Lay out the position of the twist on the metal using a pencil and scales.
2. Place the metal in the vise in a horizontal position so that the mark indicating the start of the twist is in line with the mark.

3. Secure a monkey wrench and close it on the metal at the mark which indicates the end of the twist, and turn the wrench with the right hand, supporting the stock with the other hand.
4. If the twist is to be long, secure a length of pipe which will fit over the twist and use this to keep the twist straight.
5. The twist may be straightened by laying it on a block of wood and hitting with a lead mallet.

Twisting metal adds stiffness to the piece. The stock shortens depending on the number of turns and the cross-sectional shape of the bar. If it is necessary to know the resulting size, test the shortening effect of twisting by using a scrap piece.

Forming a Flat Piece of Metal into a Cylindrical Shape. It is sometimes necessary to form a piece of copper into a cylindrical shape. This operation may be performed either over a stake or other cylindrical form or by using the forming rolls. It is not usually necessary to anneal the metal before it is formed; however, if it is soft, it will bend and hold its shape more readily.

To Form a Cylinder in the Forming Rolls.

Procedure:

1. Adjust the lower roll so that it clears the upper roll by the thickness of the metal being used.
2. Lower the back roll so that the stock will be bent slightly as it is fed between the two front rolls.
3. Feed the stock through the two front rolls adjusting the back roll in a little for each successive feeding.
4. Unlock end bearing cap when cylinder is formed, and slide the cylindrical piece off the top roll.

To Form a Cylinder By Bending Over a Stake.

Procedure:

1. Select a stake or cylindrical form of wood or metal which is slightly smaller than the diameter of the cylinder required.
2. Form the metal over a stake using a fiber mallet and directing blows as indicated in Fig. 45.

To Form a Flat Metal Ring. A flat ring may be formed in much the same manner as explained above. If the metal tends to crinkle, lay it on a flat surface and flatten it by striking it with the mallet.

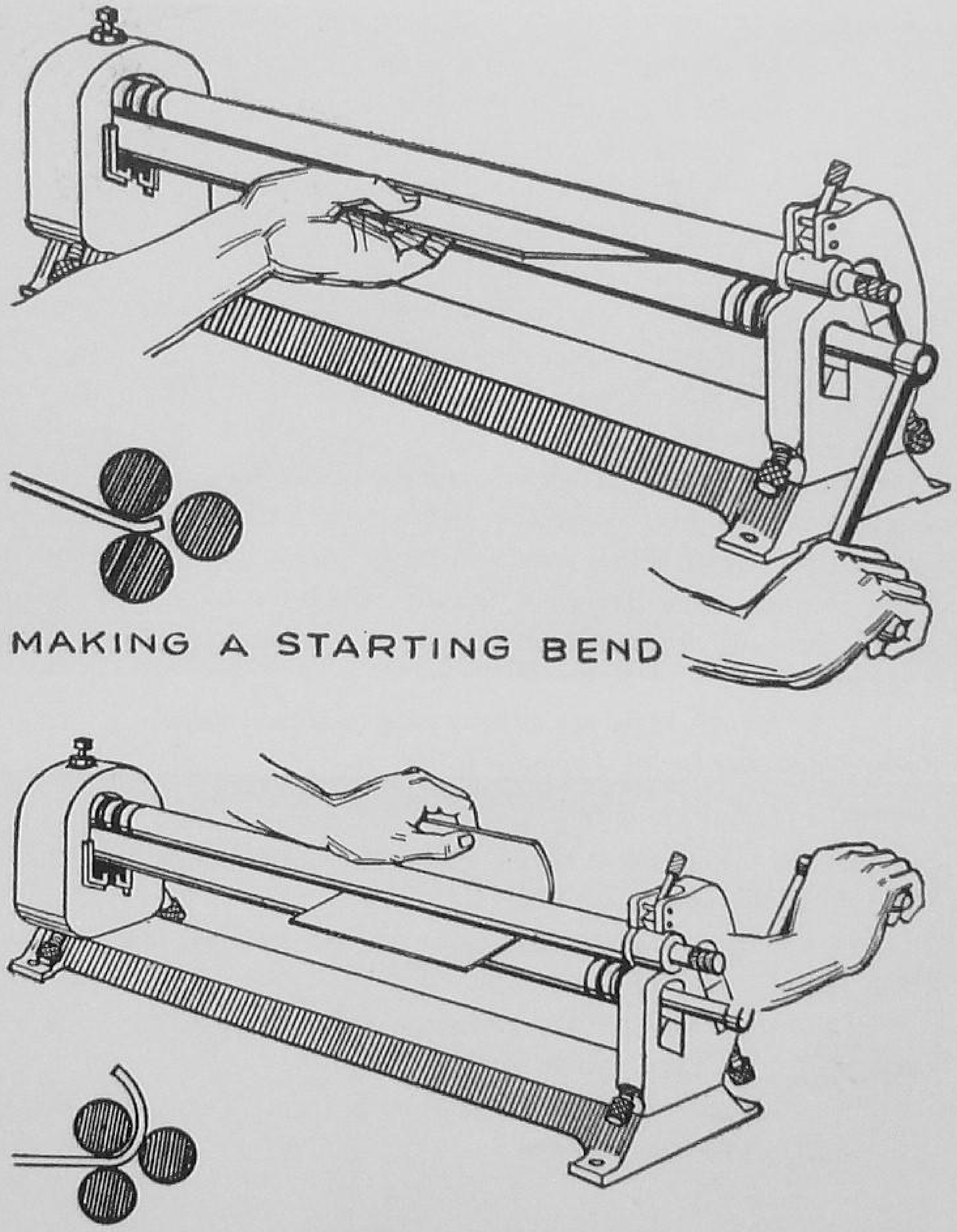


FIG. 44. Use of forming rolls to form a cylinder.

Making a Right-Angle Bend on Sheet Metals. Clean right-angle bends can be made in metal sheets with the use of two blocks of hard wood. The metal is first marked accurately at the place or places at which it is to be bent. If the metal is unusually heavy, it may be scored along the line of the bend with a blunt, cold chisel. This scoring should be done on the inside of the corner bend. The metal is placed in the vise between the two

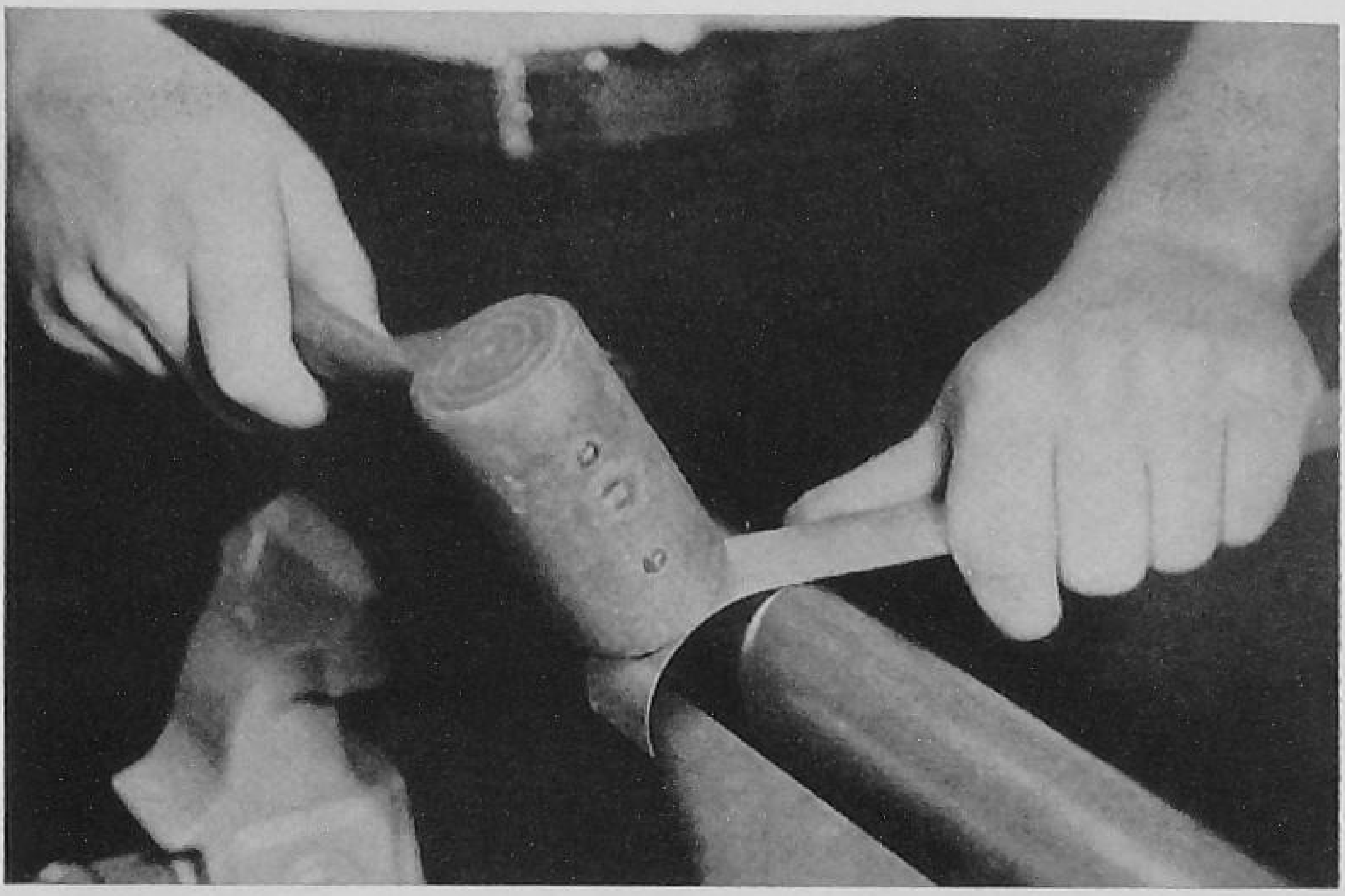


Fig. 45. Forming a cylinder using mallet and stake.

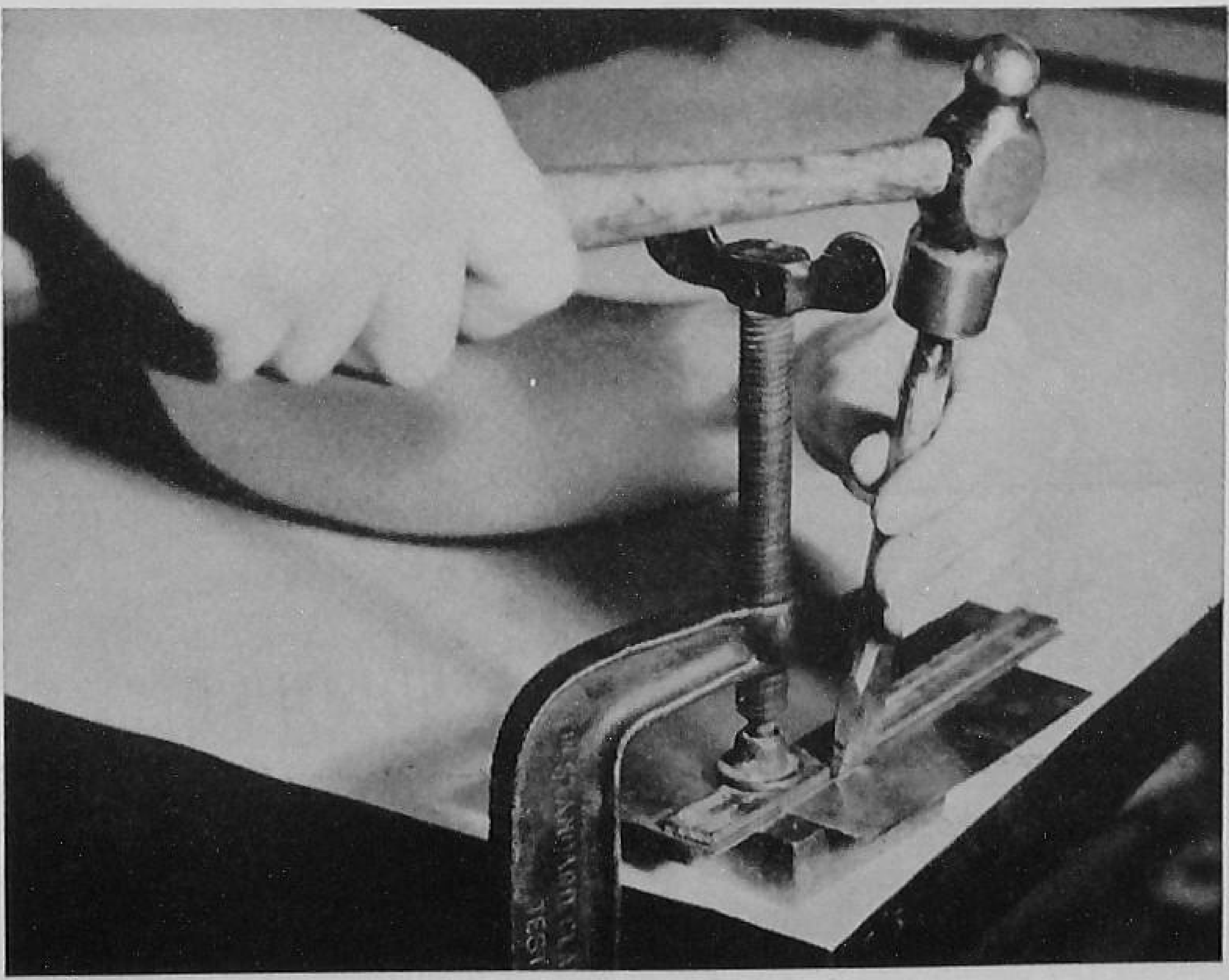


Fig. 46a. Scoring a line along the bend with a cold chisel.

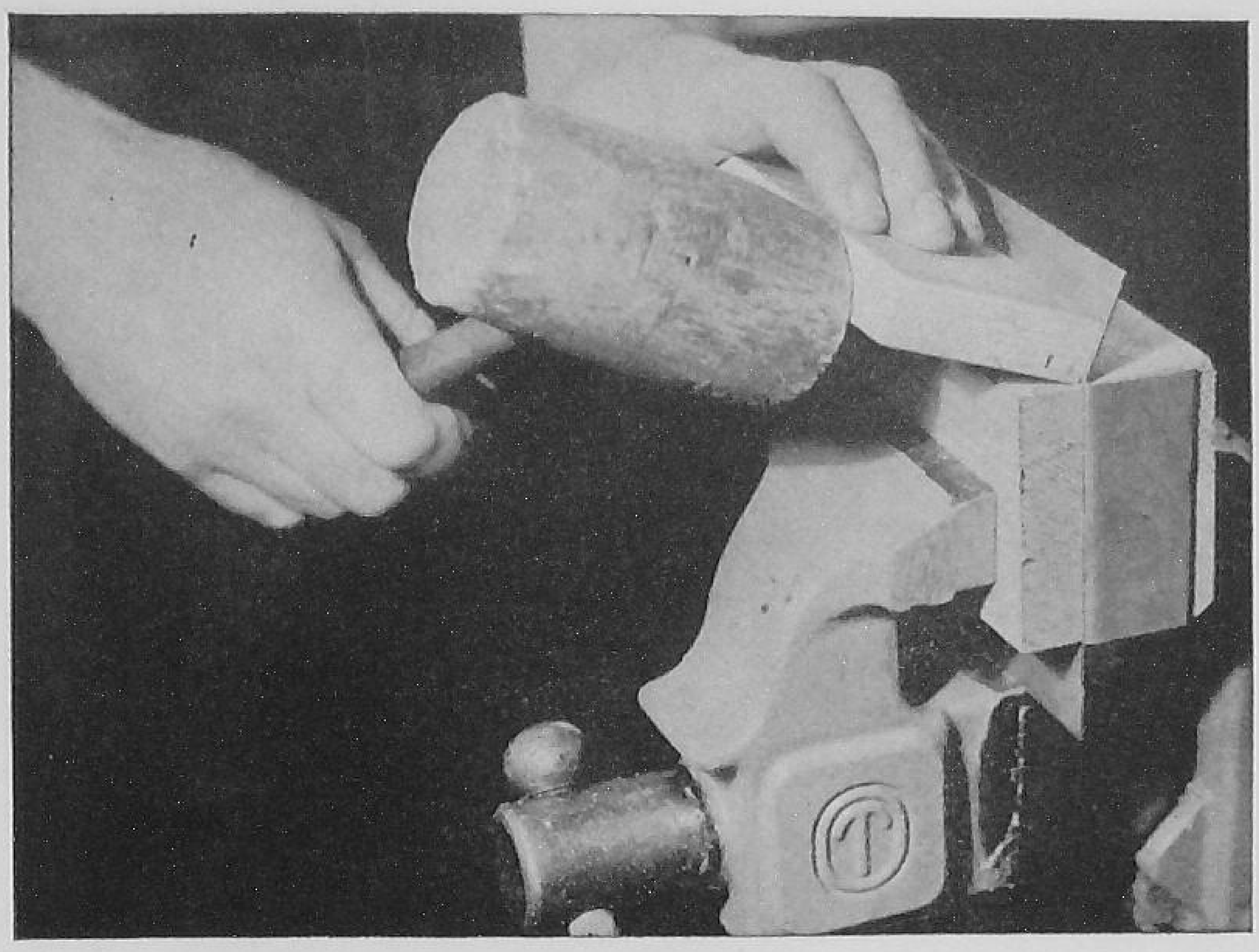


FIG. 46b. Bending the corner between blocks of wood held in the vise.

blocks of hard wood, lining up the edges of the wood with the mark on the metal. The metal is then bent carefully using a third piece of wood to back up the piece being bent. If it is desired to make several bends in the metal such as is required in a metal box, the blocks should be prepared for the size of the inside of the box. The blocks are then placed on the metal and clamped in a vise. The bends are made in the manner described above.

A bend is sometimes required on the edge of a disc of metal. Two circular forms are prepared of hard wood and the metal disc is clamped between them in the correct position. The edge is then bent over the form by using a mallet. Care must be taken not to bend the metal too fast. The metal will bend best if it is formed over the wooden block in three or four successive stages. The first stage should start the bend at about 20 or 25 degrees; each time around the circle the mallet strikes at less of an angle bending the metal nearer the form. The last time around the metal is brought up tight against the form.

FIG. 47. Bending a flange on the edge of a circular disc over a form.

Folding Seams on the Bar Folder. The bar folder may be used to fold a straight edge on a piece of flat sheet metal for the purpose of forming a seam. It is also used for producing a hem on the edge of the metal in order to strengthen the work and produce a smooth rounded edge.

Procedure for making a hem:

1. Cut out the required material allowing extra for the hemmed edge.
2. Set the bar folder for the size of hem.
3. Place the metal in the bar folder and fold the metal as far as possible.
4. Place the metal (hem up) on the top plate of the bar folder and bring the folder over to set the hem down tight.
5. If a double hem is required, set the machine for a slightly deeper hem, and repeat the above operations.

Making a Grooved Seam.

Procedure:

1. Obtain a hand groover of the required size.

2. Make the layout and cut out the metal, allowing three times the width of the groove size for the seam.
3. Cut two small scrap pieces of metal about 2″ x 3″ and the same thickness as is to be used in the project.
4. Set the bar folder slightly less than the width of the groove in the hand groover that is to be used.
5. Fold each of the scrap pieces.
6. Hook the two folds together and strike the seam lightly with a mallet.
7. Lock the seam using the hand groover and hammer. (If the seam does not lock properly, readjust the bar folder and proceed again with the scrap pieces until the seam will lock properly.)
8. Fold the seam on the project. (If the piece is to be formed into a cylinder, fold the seam in opposite directions on the flat sheet.)
9. Lock the seam with a hand groover and a hammer.

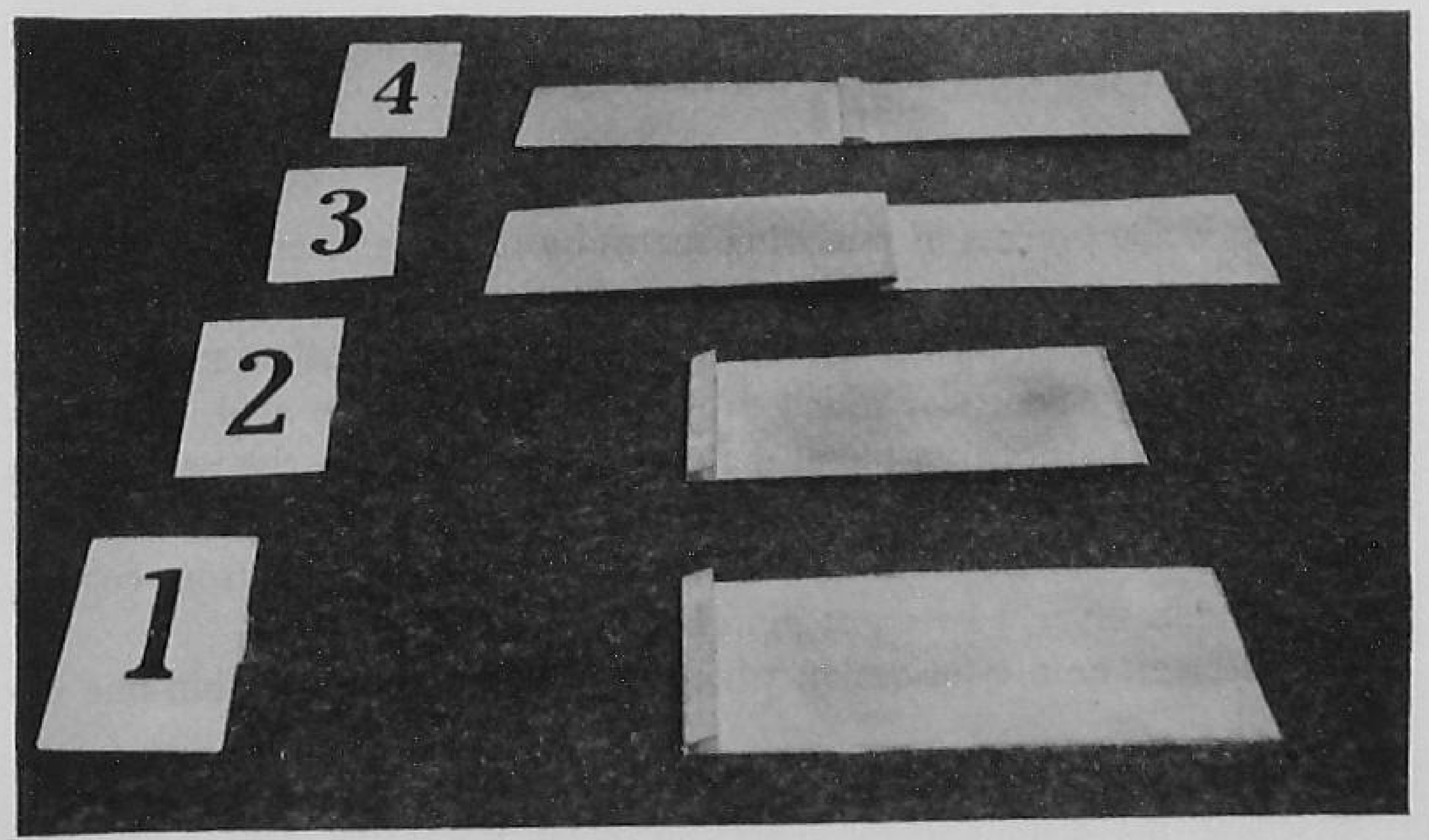


Fig. 48. Making a grooved seam.

1. One edge folded.
2. Second edge folded in opposite direction for cylindrical work.
3. Folds hooked together.
4. Seam locked with hand groover.

Wire Edge. It is sometimes advisable to insert a wire in the edge of a piece of sheet metal which is to be formed into a cylinder. The wire edge

will strengthen the top of the object and will also produce a neat, rolled edge appearance. The following procedure is recommended:

1. Select a suitable size wire and cut it slightly longer than the circumference of the cylinder, using side-cutting pliers.
2. Make the layout for the cylinder, allowing an amount equal to 2½ times the diameter of the wire for the seam.
3. Using a scrap piece for a test, set the bar folder so that the radius of the fold is the correct size for the wire.
4. Using a test piece, adjust the bar folder to fold just enough metal to completely cover the wire.
5. Insert the stock in the bar folder and fold for the wire.
6. Straighten the wire with a mallet and insert the wire in the groove provided.
7. Form the metal over the wire with a wedge-shaped mallet or setting hammer.
8. Cut the wire to length and proceed rolling the stock to a cylindrical shape in the forming rolls. The wire edge should be placed in the groove in the lower roll of the forming rolls.

Etching.

Etching is the process of removing metal by chemical means in order to produce a surface design. The portions of the design which are to be eaten away are left exposed to the action of the acid, while all other surfaces are covered with an acid resist which protects them from the acid. The success in etching a design on metal depends a great deal on the preparation of a clean blank and the exercise of care in painting the design. The procedure used to produce an etched design on an article made from copper, brass, German silver, pewter, or aluminum is as follows:

1. Select an area type design which has little or no fine, thin-line detail.
2. Trace or draw this design full-size on a piece of paper.
3. Clean the surface of the metal on which the design is to be etched with steel wool and paint it with whiting. (Whiting may be made by mixing one part whiting, five parts water, five parts alcohol and a few drops of liquid soap.)
4. When the whiting is dry, transfer the design on the metal, using carbon paper (Fig. 49).
5. With a fine scratch awl, scratch the design into the metal. Scratch only deep enough so that the design may be seen when the whiting

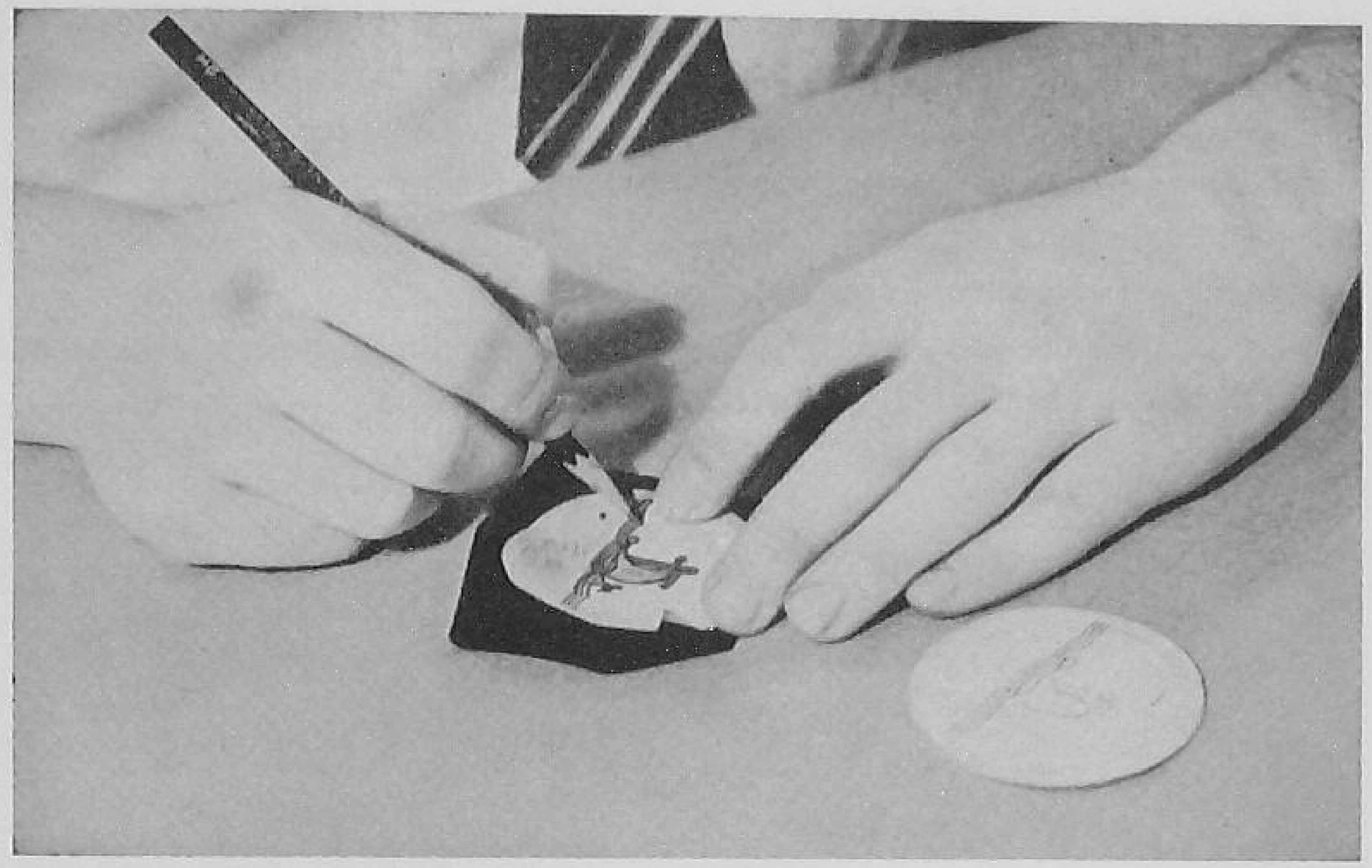


FIG. 49. Transferring the design on the metal.

is removed (Fig. 50). Avoid unnecessary lines as they will be difficult to remove later.

6. Wash off the whiting with water and clean both sides of the metal with fine steel wool. Avoid handling surfaces which have been cleaned.

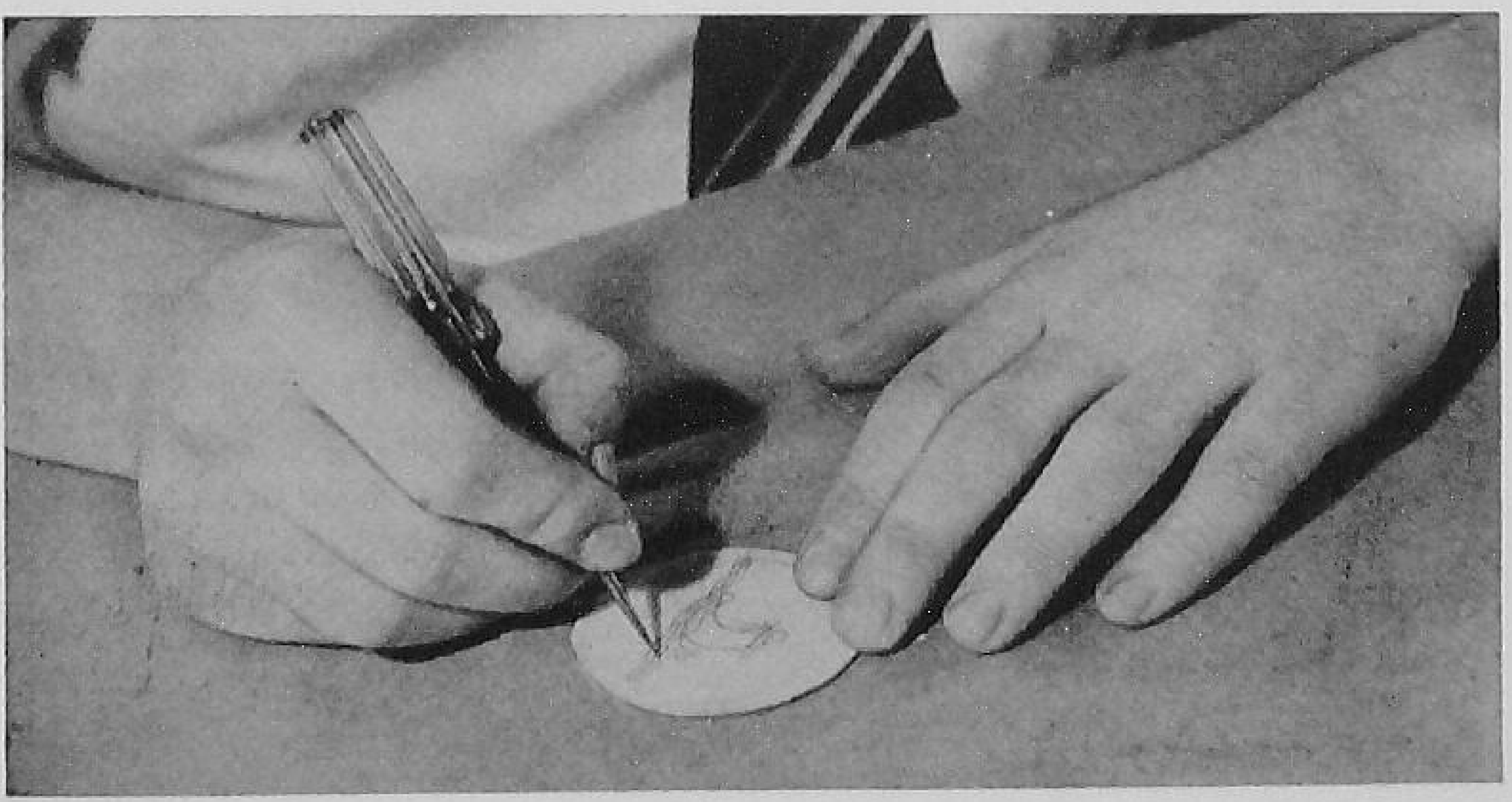


FIG. 50. Scratching the design into the metal.

7. Lay the face of the piece on clean paper and paint the back and edges of the metal with black asphaltum varnish, being careful to cover the metal completely.
8. Cut a piece of cardboard slightly larger than the metal and, when the varnish has become tacky, place the cardboard on the varnished surface and turn the metal over.
9. Paint all the surfaces of the design which are to be protected from the acid (Fig. 51). Allow the asphaltum to dry overnight.

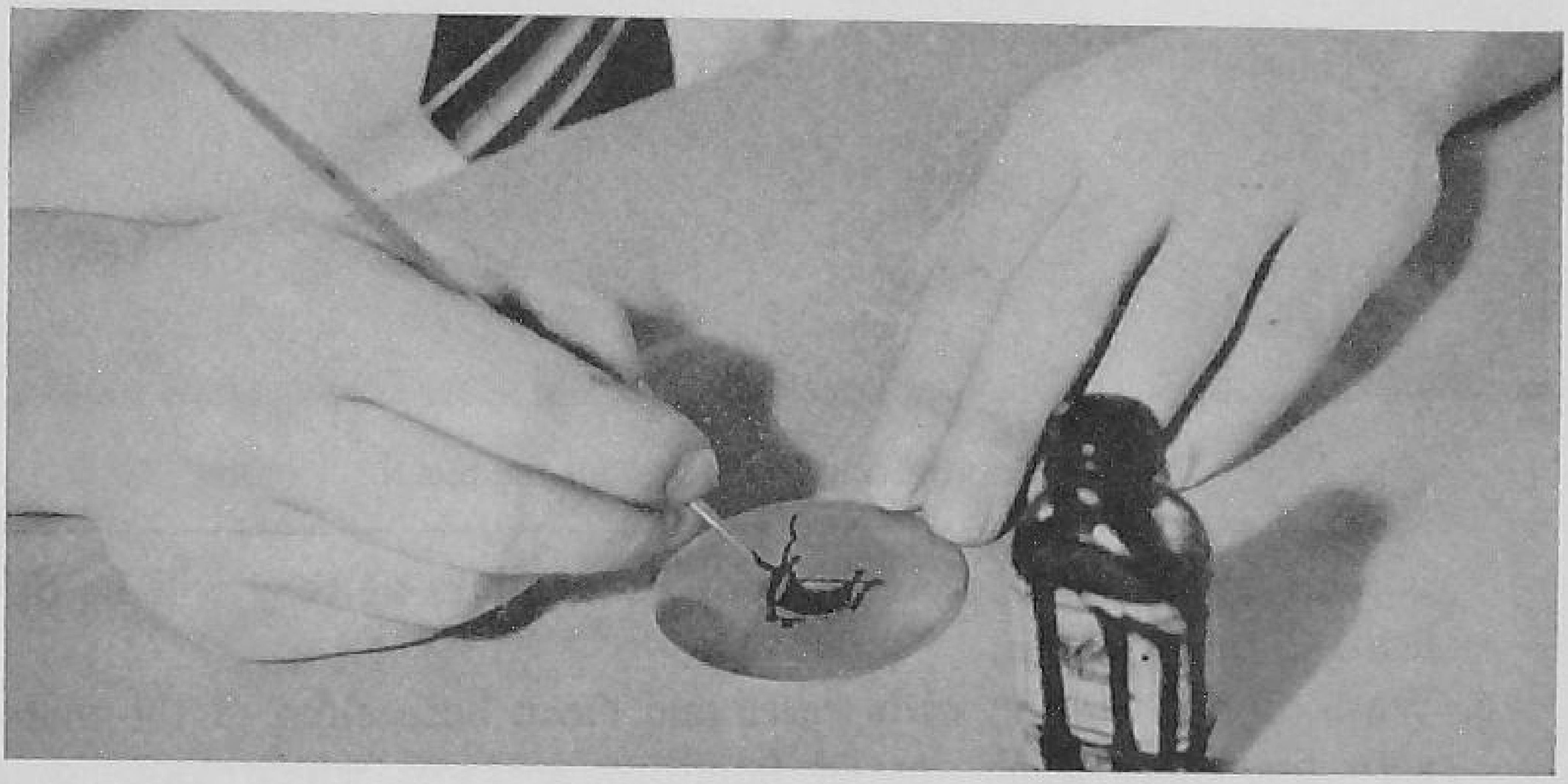


FIG. 51. Painting the design.

10. Examine the work for spots which are not covered with asphaltum. Touch up if necessary.
11. Place the work in the proper etching solution and allow the surface to etch. For a clean-cut, even etch, bubbles may be brushed from the surface of the metal with a feather. The length of time required for etching depends on the strength of the acid, the temperature of the acid, and the kind of metal. Inspect the progress every 10 minutes, and remove the work from the acid if any asphaltum is being lifted by the acid. If the depth of the etched design is not deep enough, the parts may be repainted and, after dry, the work may be placed in the acid again.
12. When the surface is sufficiently etched, remove the work from the acid and wash thoroughly in water.
13. Remove the asphaltum varnish with turpentine or lacquer thinner.

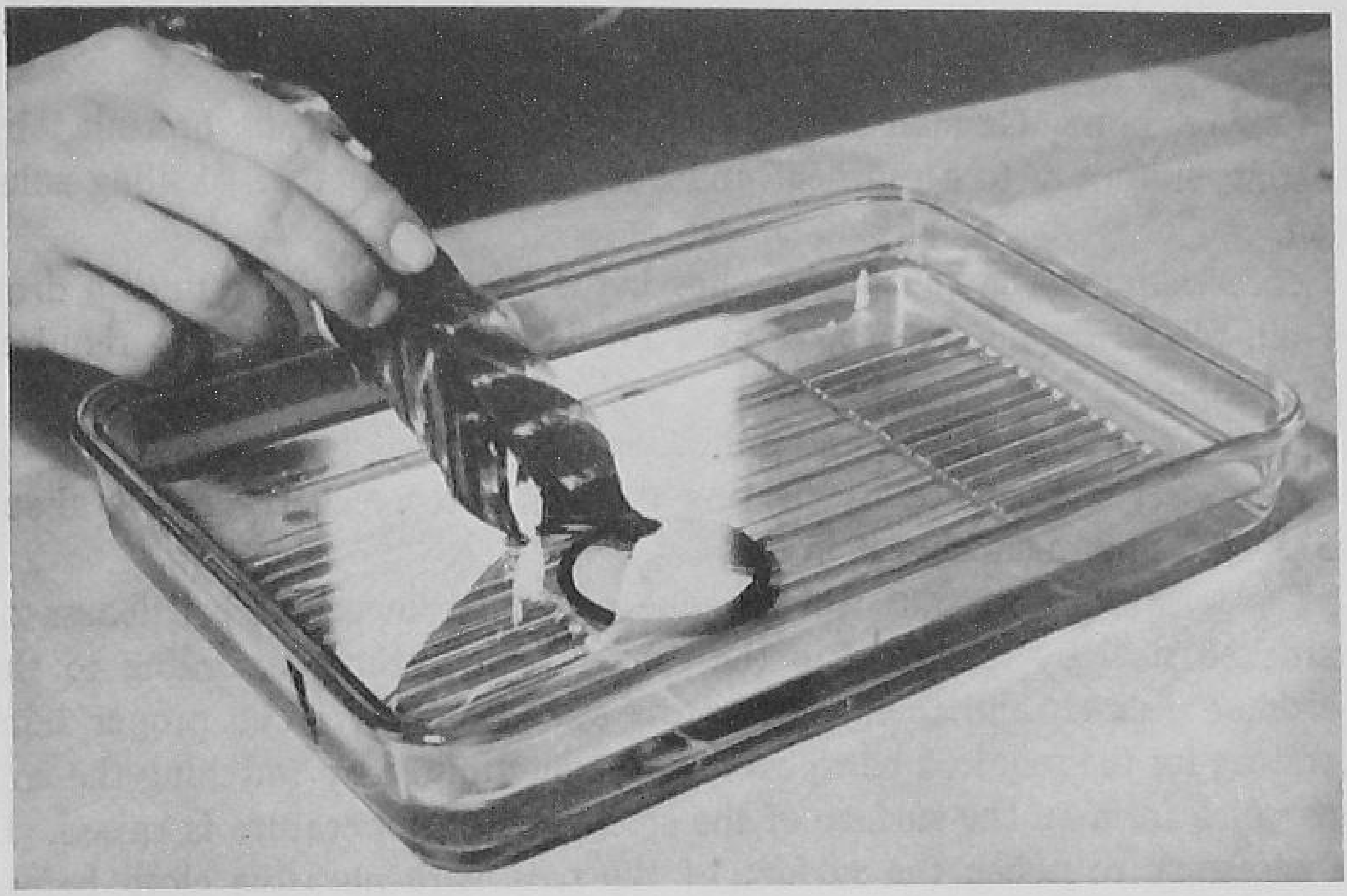


FIG. 52. Etching the design.

Etching Solutions:

Etching solution for *copper or brass*:

To three parts of water, add one part nitric acid.

Etching solution for *German silver,* and *pewter*:

To four or five parts water, add one part nitric acid.

Etching solution for *aluminum*:

To three parts water, add one part hydrochloric acid.

Caution: Always add the acid to water, never the water to acid, as steam is generated and will cause a small explosion.

Heat Treatment.

Annealing is the process of softening metal by heat treatment. All the metals used in the metalcraft shop are hardened by mechanical means, such as hammering, bending or rolling. If the metal is allowed to harden, further working may cause the metal to crack because of strains set up in the hardening process. The size of the work to be annealed will determine the source of heat needed for annealing. A Bunsen burner may be a sufficient source of heat for small work. A soldering furnace or blow torch may be necessary for larger work. Avoid placing the work in a soldering fur-

nace without protecting the work from the dirt at the bottom of the furnace.

Copper, brass, German silver, and sterling silver may be annealed by heating uniformly to a red heat and quenching in water or pickling solution.

Aluminum may be annealed by heating slowly over a flame until a drop of oil, placed on its surface, reaches its flash point. Aluminum requires no pickling.

Pewter generally requires no annealing.

Tool steel is hardened by heating the piece to a "cherry red" (about 1375° F.) and quenching it in oil.

Tempering is a process which reduces the hardness and brittleness of hardened steel by reheating to the proper temperature, according to the hardness desired, and then dipping the steel in water. The proper temperature for the required hardness may be determined by watching the colors which form on the surface of the steel as the temperature is raised. It is necessary to polish the surface of the part with abrasive cloth before tempering so that the colors can be seen more easily. A chart of colors for hardening various common tools follows. Care must be taken to reheat rather slowly, so that the proper color can be determined.

Tempering Colors for Various Tools

Tools	*Color*	*Temperature (° F.)*
Scrapers, engraving tools	None appears	200 (about the boiling point of water)
Awls, punches, chasing tools	Straw yellow	450
Plane iron and twist drills	Brown yellow	500
Hammers	Brown yellow	500
Cold chisels	Brown purple	550
Knives, screwdrivers, saws	Red purple	575
Springs	Blue	580–600

Steel is annealed by heating it to "cherry red" and cooling slowly. The slower the cooling, the softer the steel will become. It is good practice to allow the steel to cool with the furnace as it cools.

Pickling.

Pickling, in metalcraft, is a term given to the process of removing oxides, which form on the metal when it is being heated, by the use of acid. The

acid dissolves the oxides which are formed on the metal surface and aids in the cleaning of the surface of the work with abrasive before it is polished. Pickling acid should be kept in a glass container large enough to handle the bulk of work to be done in the shop. A jar of water near the pickling acid is handy to use as a rinse, and an alkaline neutralizer in a third jar may be used to neutralize the action of the pickling acid.

Pickling Solution. To make up a pickling solution for copper, brass, and German silver:

To twenty parts of water, add one part sulphuric acid and stir with a wooden stick.

Caution: Always add the acid to water; never the water to acid.

Neutralizing. A saturate solution of sodium bicarbonate and water will make an effective neutralizer.

Procedure:

1. After annealing, plunge the red-hot metal into the pickling solution. (Stand back at arm's length from the pickling solution.)
2. After a minute or two, remove the object from the acid with a piece of wood or pick-up tongs.
3. Rinse the metal in water and dip it in the neutralizer.
4. Rinse again in water and dry the metal with a clean rag.

Cold pickling will remove oxides but requires more time than heated work. Extreme care must be taken when working around acids to see that none splashes on the body or clothing. Tools must be kept away from acids and acid fumes to prevent corrosion.

Tooling Metal Foil.

Thin sheet copper or brass foil can be tooled in order to produce a three-dimensional design on its surface. This medium is excellent for craft work where a minimum of equipment is available. Either 34 or 36 B & S gage metal is the most satisfactory. A leather-working *modeling tool* is ideal for this work; however, an orange stick or a dowel rod, shaped to resemble a thumb on one end and pointed like a pencil at the other, will do. The ends of the tool must be smooth.

Procedure:

1. Select a suitable subject for the design. Pictures of landscapes are in general too complicated for this kind of treatment. The human figure is an excellent subject if the composition lends itself to outlining

and does not require too much detail work. Flowers are usually workable subjects. Newspapers and magazines abound with suitable material.

2. Cut the sheet metal to the desired size with scissors and smooth it out with a wooden rubbing tool (a small sandpapered flat piece) on a glass slab. Be sure to leave sufficient border space.
3. Whiten the back surface of the copper with a solution made of 1 part whiting, 5 parts water, 1 part alcohol, and a drop or two of liquid soap. Trace the design on the whitened surface with a dull-pointed tool. Another method is to fasten the paper, carrying the design, onto the back of the metal sheet and trace the design with a dull point directly into the metal. Use only a light pressure for the design lines.
4. Place the metal foil on the felt pad and go over the outline with a *tracer* or blunt-pointed wooden tool.
5. The metal foil is then placed with the front side down on a felt pad, and those portions of the design that are to be raised are gradually pushed into the pad. The pressure is applied on the inside of the outlines with the small modeling tool, being careful to keep the outlines distinct. The modeling tool is moved with firm straight or circular strokes, and with moderate pressure in the areas to be raised. Do a little at a time, and be sure not to push the surface out too far, as they cannot be molded back, and too much stretching may rupture the metal. A *ball end* or *deer foot* modeler will help in getting into narrow spaces.
6. After the work is partially done, turn the metal over, and press the background and borders around the raised portions down on a glass slab or piece of hard wood, to keep the outlines clear and the background in the original plane.
7. At this point the background may be stippled by tapping with a blunt tool in order to provide a pleasing contrast. Take care not to put a hole through the thin metal.
8. After the design is all done, it is a good plan to fill the depressed portions on the back with a material which will harden and so prevent the thin metal from denting. Many commercial compounds are available but a simple, effective one may be made by mixing plaster of Paris and metal lacquer to a thick consistency. Clean the depressions in the work and apply a coat of metal lacquer. Fill the depressions with the filler and allow to dry in a horizontal position for

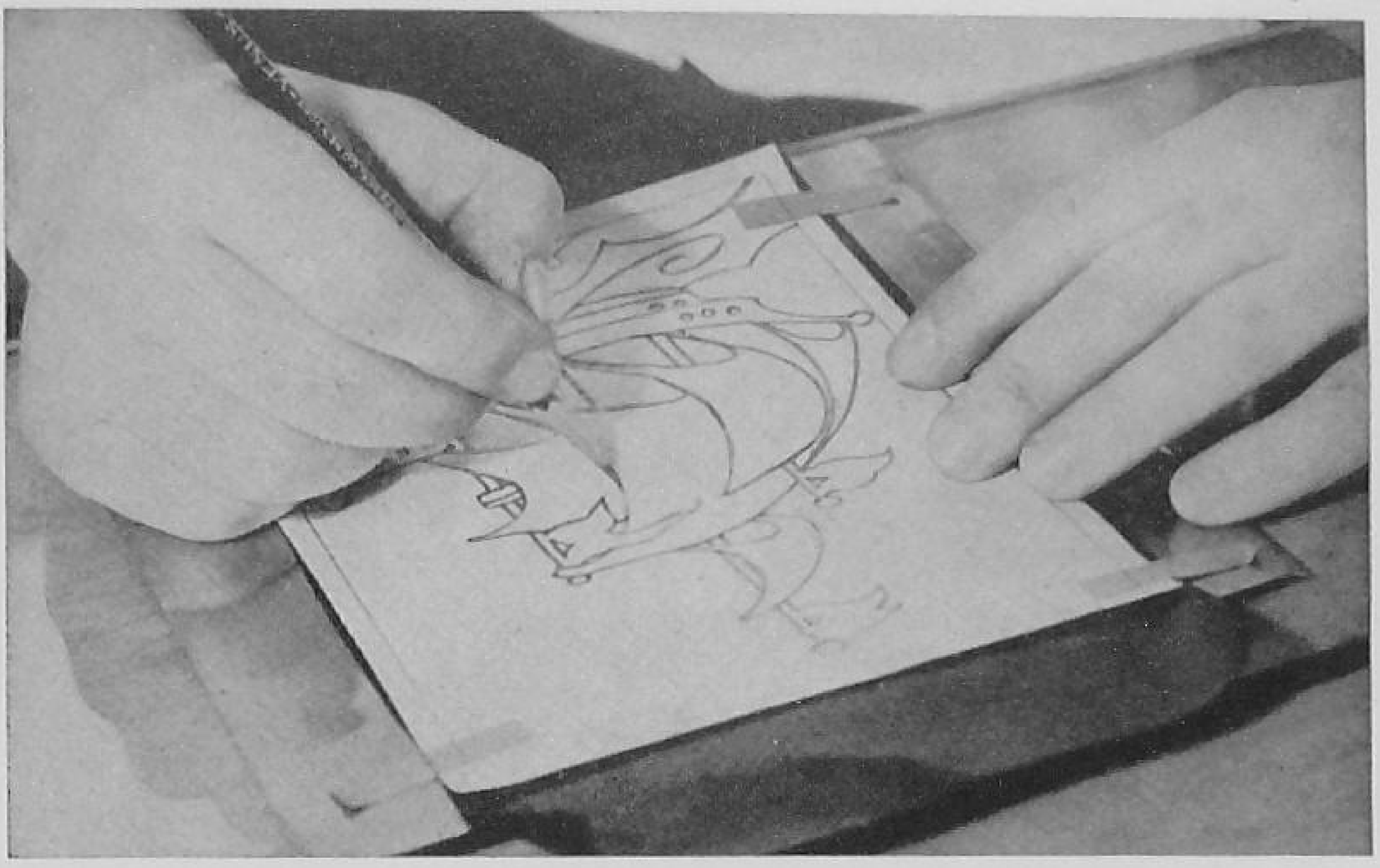


FIG. 53a. Trace the design on the metal with a hard pencil.

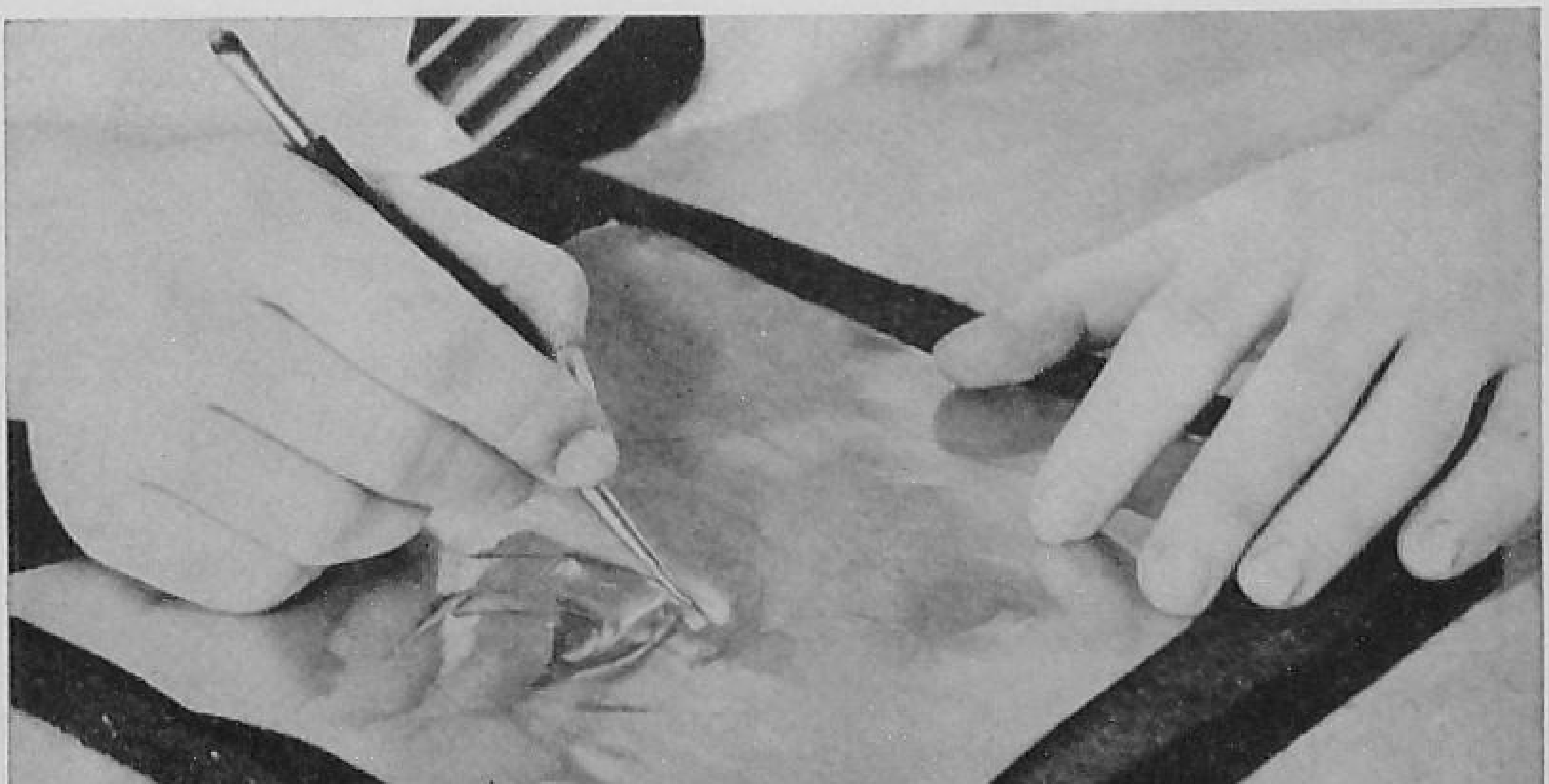


FIG. 53b. Outline the design with the tracer end of the modeling tool.

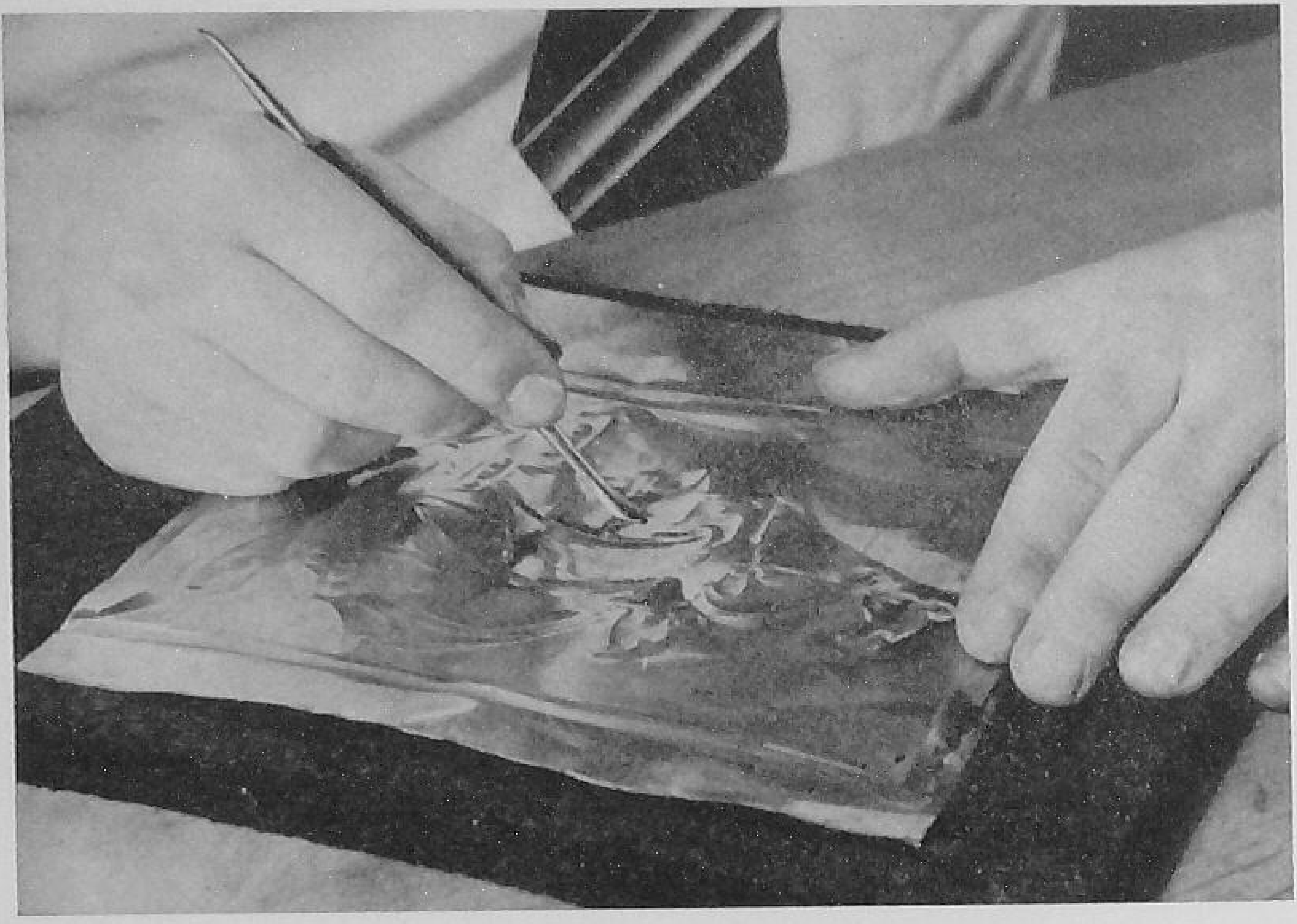


FIG. 53c. Raise the design from the back with the spoon end of the modeling tool.

FIG. 53d. The work is reversed on a glass slab to press the background in the original plane.

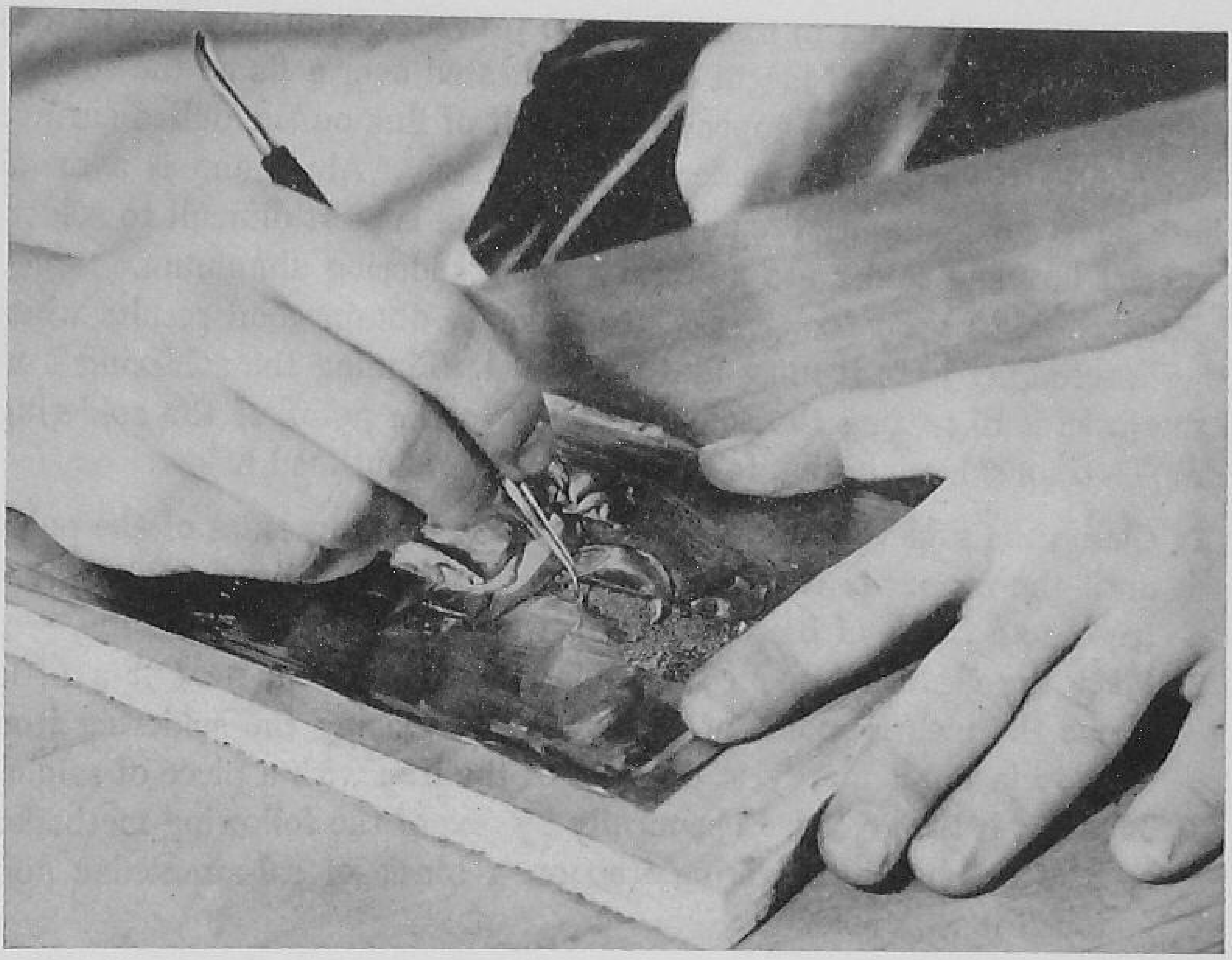


FIG. 53e. The background may be stippled in order to provide a contrast.

at least 24 hours. The picture is then fastened to a wooden piece with small brass nails called *escutcheon pins*.

9. Finish by polishing and lacquering or by antiquing and waxing.

Soldering.

Soldering is classified as being either hard or soft, depending on the type of solder which is used. A joint soldered with hard solder is stronger than one soldered with soft solder; however, soft solder is more easily used. In soldering, the heat is produced either directly on the metal as with a torch or Bunsen burner or indirectly with a soldering copper. In all soldering, there are four important factors which must be observed in order to produce a neat, strong joint:

(1) The work to be soldered must be cleaned with meticulous care.

(2) The proper flux and solder for the particular metal must be used.

(3) The metal must be heated to a temperature slightly higher than the melting point of the solder being used.

(4) The solder must be allowed to cool slowly.

The function of a flux in soldering is to prevent oxidation when heat is applied. When a piece of bright copper is heated over a flame the surface will quickly become dull in appearance. A bit of flux on the dulled surface will brighten it so that the solder will flow freely. Aluminum is a metal whose surface oxidizes most readily and therefore is most difficult to solder. A special flux and solder are necessary when soldering aluminum.

Soldering with a Soldering Iron. In order to obtain good results when using a soldering iron, it must first be tinned. Tinning the soldering iron is the process of getting the solder to stick to the point of the soldering iron. To tin a soldering iron, follow the procedure outlined below:

1. Clamp the soldering iron in a vise and file the four sides of the point until the copper is clean and bright. A piece of abrasive cloth fastened to a block of hard wood will work well in place of a file.
2. Place the cleaned iron in the soldering furnace and heat it a little above the melting point of solder. Avoid placing the soldering iron directly in the flame. Test the heat of the iron with a piece of solder.
3. The iron is then cleaned chemically by one of the following methods:
   a. Rub the heated soldering iron on a block of sal-ammoniac and touch it with solder.
   b. Prepare a saturate solution of sal ammoniac powder (ammonium chloride) and water. Dip the tip of hot soldering iron in this solution and touch it with a piece of solder.
   c. Dip the point of the heated soldering iron in rosin paste flux and touch it with solder.
   d. Prepare a "dip" by mixing a commercial soldering salt as directed on the container, and use as above.

To Solder a Joint Using the Soldering Iron.

Procedure:

1. Clean the surfaces of the metal to be soldered using steel wool. Some metals require more cleaning than others. Tin plate should be cleaned very lightly, if at all, as the plating will be removed if much abrasion is used. Copper, brass, German silver, aluminum, and pewter may be cleaned with steel wool whereas iron or steel must be cleaned by using abrasive cloth or filing.
2. Select a soldering iron large enough for the job. A small iron will not give sufficient heat for soldering a piece having a large surface.
3. Arrange the work in a convenient position on a piece of clean asbestos

(transite) board or some material which will not absorb the heat from the iron.

4. Apply the flux to the metal at the joint.
5. Tin the soldering iron as explained above.
6. If the joint is long, "tack" it in several places in order to hold it in position.
7. Place the heated soldering copper on the work and feed the solder to the tinned tip, allowing the metal to heat so that the solder flows from the heated iron to the joint. Hold the piece down with the tang of a file or some other tool if there is a tendency for the metal to shift as it is being soldered.
8. Move the soldering iron along the seam at a speed that will preheat the metal ahead of it so that the solder will flow into the joint. As the solder is being used, feed solder to the iron at the tip.

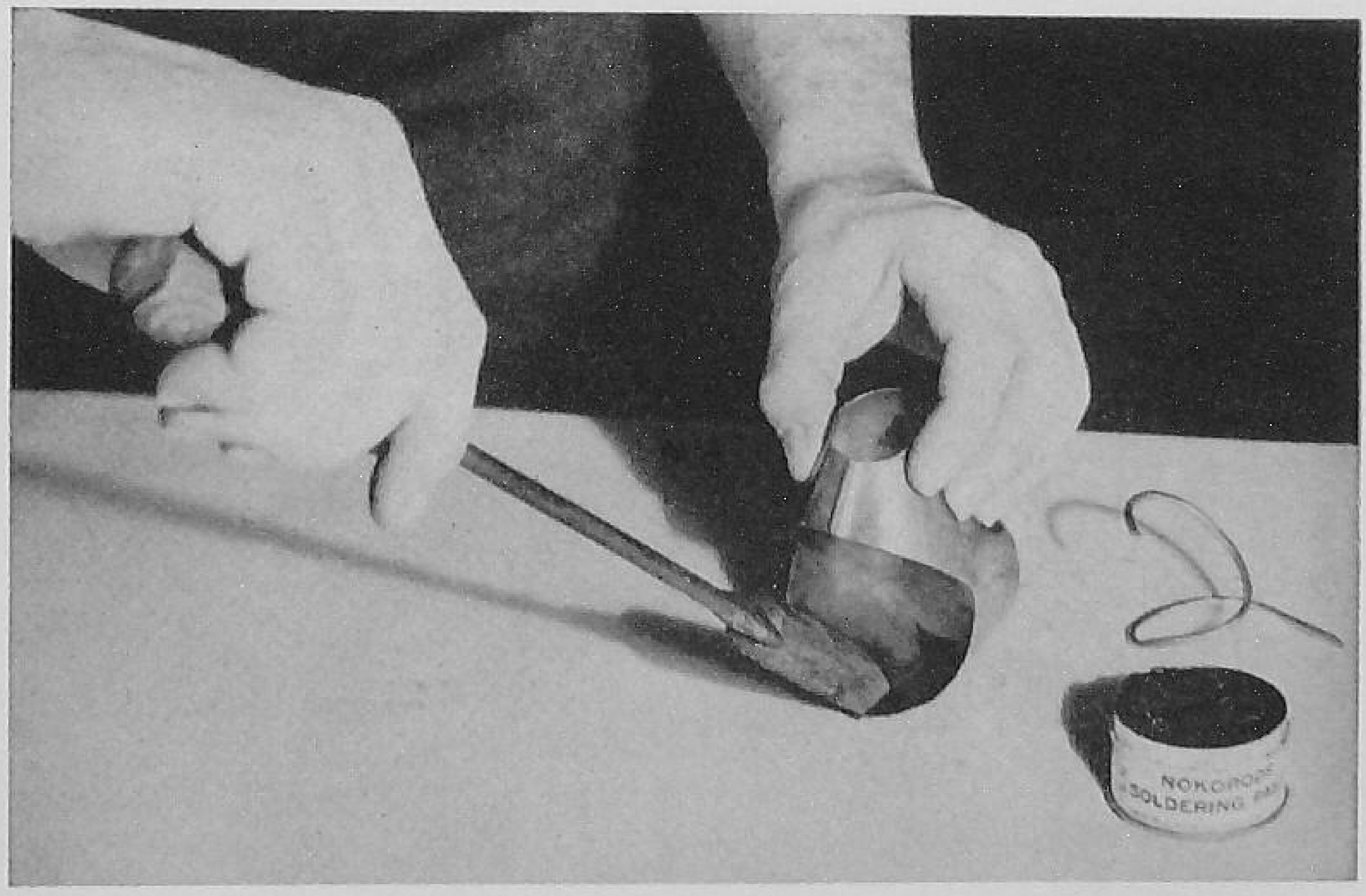


FIG. 54. Soldering a joint with a soldering iron.

Clamping and Wiring Work to be Soldered. The method used in holding pieces to be soldered will vary depending upon the size, shape, and placement of the work which is to be soldered. Most pieces are best held with annealed iron wire. The joint is first fitted carefully after which each piece is cleaned near the joint with steel wool and the pieces are tied to-

gether with iron binding wire. Wire of a gage strong enough to hold the pieces securely should be used. The wire is tightened by twisting the ends together until the joint is brought in place.

For some pieces on small work, a small cotter pin or bobby pin can be used to good advantage as a clamp to hold pieces to be soldered. There is a metal clamp on the market which is much like a spring-type clothespin which is handy for clamping larger work. Small "C" clamps are also handy for sweat-soldering flat pieces.

Soft-Soldering with Direct Heat. Soft-soldering is usually done with solder made of 50 per cent tin and 50 per cent lead which melts at approximately 414° F. A good form of solder to use when soldering with direct heat is a wire solder. The wire can easily be cut into small pellets and placed on the joint. It is essential that the work be cleaned and that the proper flux be used. The source of heat may be a Bunsen burner, a blow torch, or an alcohol lamp.

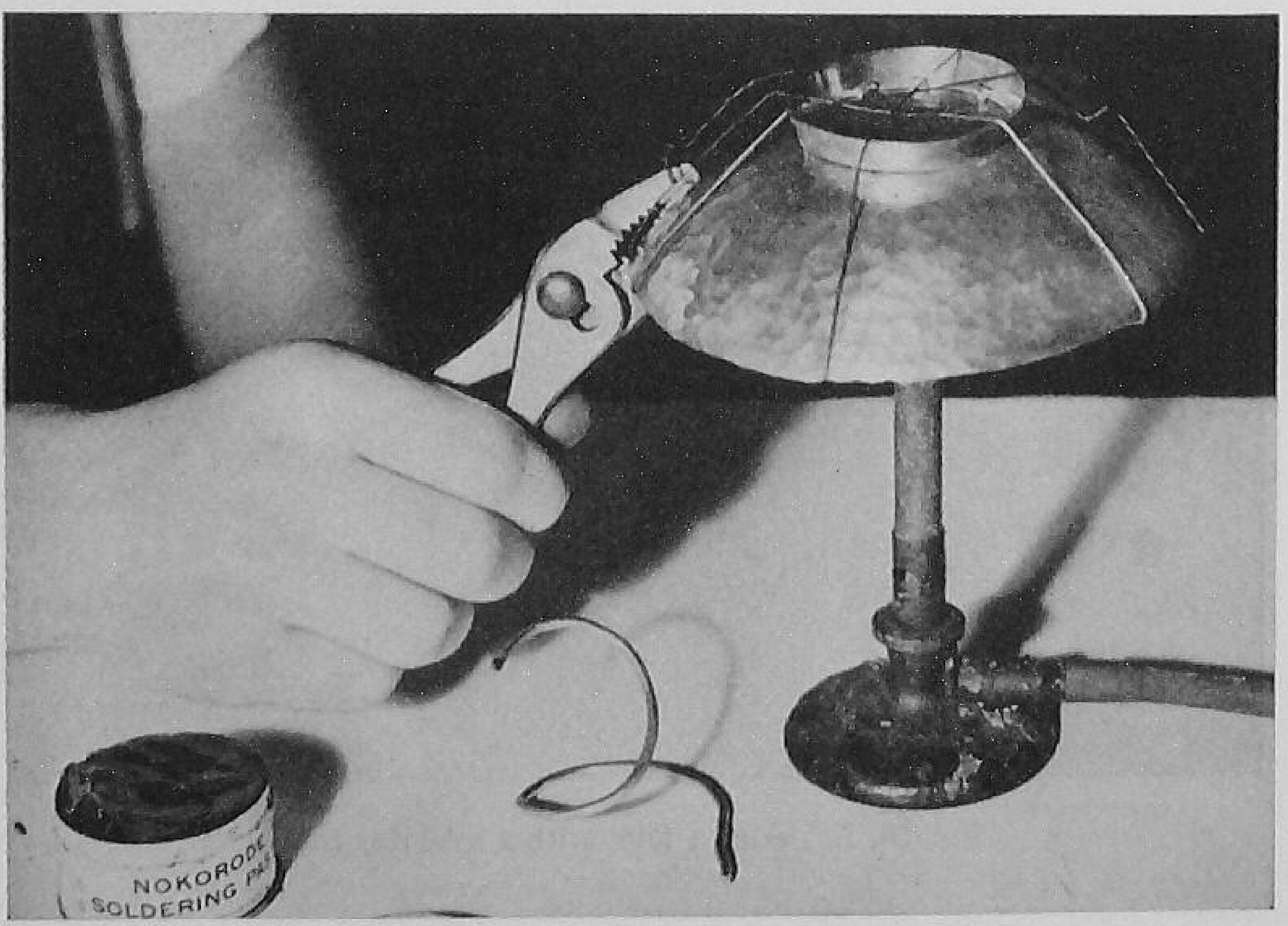


FIG. 55. Soldering with a Bunsen burner.

Procedure:

1. Clean the pieces to be soldered thoroughly.
2. Wire or clamp the pieces in place.

3. Apply flux to the joint to be soldered.
4. Prepare small pieces of solder and place them along the joint.
5. Apply the heat in such a way that both pieces to be soldered heat evenly. (Large area pieces need more heat.)
6. Allow the flux to boil and the solder to melt and run into the joint.
7. Allow piece to cool, wash off excess flux with soap and water, and remove wire or clamps.

Sweat Soldering Two Pieces of Metal.

Two pieces of metal can be sweat-soldered together in much the same manner as one glues two pieces of wood. This process is used when the joint surface is large enough to produce a strong seam and when it is desirable to solder without allowing the solder to be seen.

Procedure:

1. Clean both pieces thoroughly.
2. Apply flux to each piece and heat the smaller of the two with a flame until solder melts on the piece.
3. Touch a piece of solder to the surface and allow the solder to run on the entire surface of the piece. Use a piece of steel wool to spread the solder evenly. This process is known as tinning.
4. If the second piece to be soldered is identical in shape, the above procedure is repeated. If the second piece is larger than the first, it does not need to be completely tinned. Take care to keep the solder hidden as it is difficult to remove.
5. Clean the surfaces of the pieces again and apply flux again to each.
6. Clamp or wire the pieces together.
7. Heat the pieces until the solder has melted. A piece of solder may be used to test the heat by touching it to the clamp. (If the solder melts, the correct heat has been reached.)

Soldering Pewter.

Pewter, because of its low melting temperature, is more difficult to solder. It is soldered best with a special low melting point solder known as pewter solder. The best form for use is the wire solder. It may be flattened into a thin ribbon by hammering. A special flux is used as described in the preceding chapter. A small flame on the Bunsen burner or an alcohol lamp will be sufficient for all work.

Procedure:

1. Clean the joint with steel wool.
2. Clamp or wire the work. (Pewter is heavy enough to be soldered without wiring or clamping in some instances.)
3. Apply pewter flux to the joint and place a series of small pellets, cut from the pewter solder, on the joint.
4. Heat the joint carefully. Apply the heat by moving the flame along the joint, watching the solder. The moment the solder melts, withdraw the flame. (Take care not to overheat small sections. Apply the heat in such a way as to heat both pieces equally.)
5. Allow the work to cool slowly, remove clamps or wire, and wash off excess flux with soap and water.

Fastening Work with Rivets.

Rivets used in the metalcraft shop are generally of the round-head type and are either finished by filing flush after heading over in a countersunk hole or by forming a rounded head. The rounded head may improve the appearance of the job if it is hammered with the ball end of the ball peen hammer. This peening process produces a series of facets which may be desirable. A rivet set may be used in some cases to produce a smooth round-head on the rivet. Rivets may be made of the same material as the work being riveted or may be of a contrasting metal.

Procedure:

1. Locate the position of the rivets on the metal.
2. Drill the hole for the first rivet in both pieces. Holes in thin sheet metal may be punched with a solid punch rather than drilling.
3. Place the rivet in the hole and cut it off so that it extends through the metal a distance about equal to the diameter of the rivet.
4. Clamp the proper size rivet set in the vise and hold the work so that the head of the rivet fits into the spherical depression in the rivet set.
5. Strike the rivet with the face of the hammer in order to "upset" the rivet so that it fits tightly into the hole prepared for it.
6. Head the rivet over with the ball end of the hammer, directing the blows in such a way as to form a uniform rounded head.
7. If the rivet is to be headed with a rivet set, a second rivet set is placed over the rivet after the rivet has been upset, and the rivet set is then struck with the hammer until the rounded head is formed.

Care must be taken not to mar the surface of the metal being riveted with the rivet set.

8. After the first rivet is secured, the holes for the remaining rivets are drilled or punched and the above procedure is repeated.

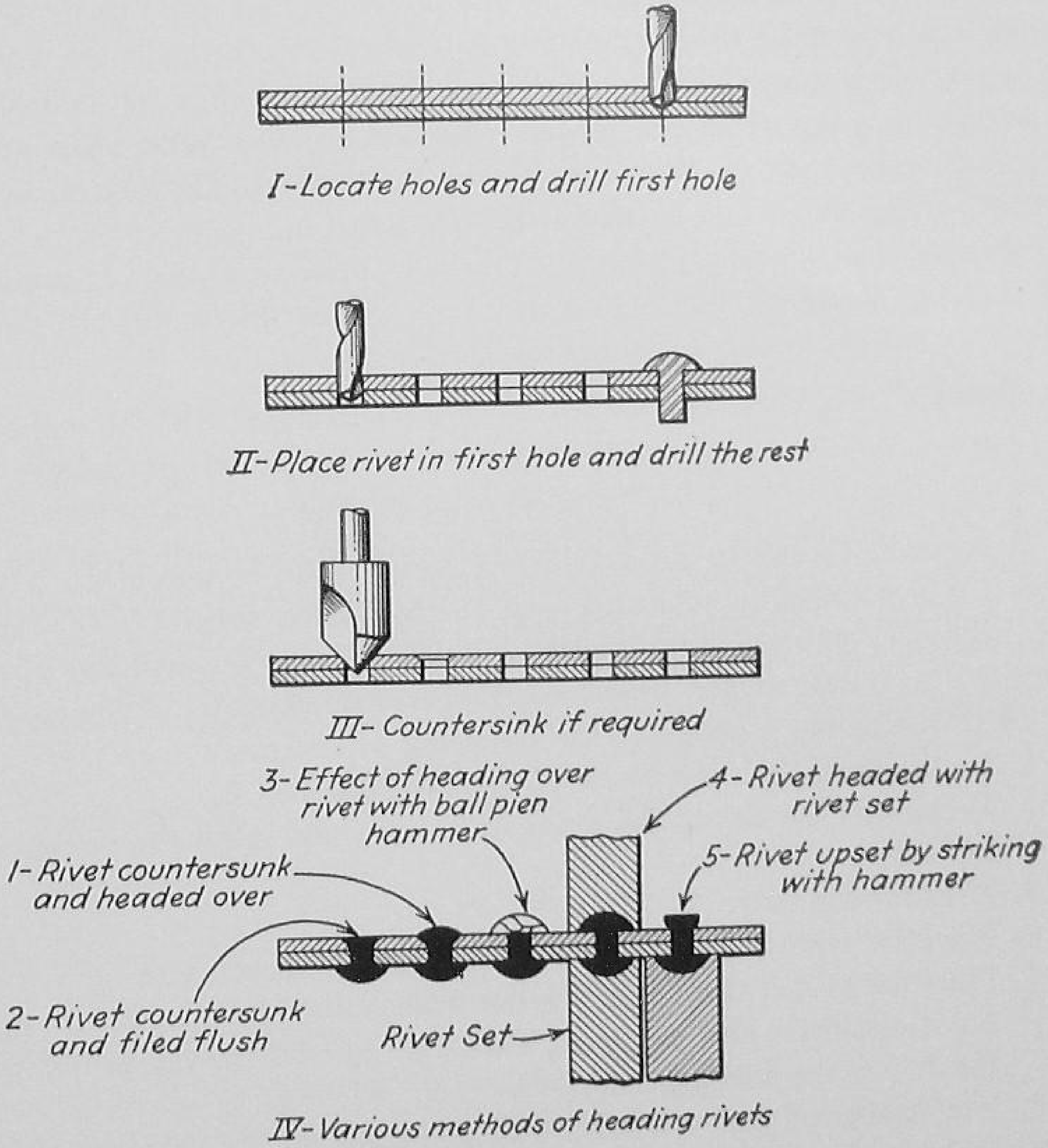


FIG. 56. Fastening two pieces of metal with rivets.

When riveting work that cannot be held on the rivet set because of its shape, the riveting can be done on the horn of an anvil, a stake, or a piece of metal especially prepared for the work, held in a machinist's vise.

Flush riveting may be done on thick metal by countersinking the hole slightly and heading the rivet over as explained above. The rivet is then filed flush with the surface.

Internal and External Threads.

In order to produce an internal thread for fastening with a machine screw or stove bolt, a hole must be first drilled of the proper size. This hole is called the *tap hole* and is drilled with a *tap-drill.* A tap-drill is an ordinary drill of the proper size for the particular tap to be used. If possible, the hole to be threaded should extend entirely through the work as a blind hole is more likely to cause breakage of taps. The tap is held and turned with a tap wrench. Care must be used in selection of a tap wrench of a convenient size in order to start the tap straight. Cutting oil is used when cutting threads on all metals except cast iron.

The tap-drill size is determined by using a table or, if none is available, it may be figured by subtracting the reciprocal of the number of threads per inch from the outside diameter of the thread.

Example: Tap size 3/8-16 (The 3/8 is the nominal size of the screw and 16 is the number of threads per inch.)

$$3/8 - 1/16 = 5/16 \text{ tap drill size}$$

A common thread to be cut in metalcraft work is the 1/8-27 N.P.T. which is a standard pipe thread used on most lamp sockets. Pipe-thread tap-drill sizes must be determined by table because the nominal size of pipe is a good deal smaller than the actual outside diameter of the pipe.

To drill and tap a hole, use the following procedure:

1. Locate the hole to be threaded and center-punch it.
2. Determine the size of the screw to be used and select the proper size tap drill.
3. Drill the tap hole.
4. Place the work in a horizontal position in the bench vise.
5. Place the proper size tap in the tap wrench and start the tap by turning it clockwise into the hole. Take care to hold the tap in line with the axis of the hole being tapped.
6. Use cutting oil and continue turning the tap until a complete thread is obtained.
7. Remove the tap by turning it counterclockwise.

A taper or plug tap is used in threading a through hole. A blind hole must be finished by using a bottom tap.

External threads are cut on cylindrical stock by the use of a die and die stock. The procedure is more simple than cutting an internal thread. The outside diameter of the rod determines the size of die to be used. Pipe threads are cut with special dies which cut a slightly tapered thread

on pipe. The size of the pipe die to be used on a given size pipe is the nominal size of the pipe. This is slightly larger than the inside diameter of the pipe for most sizes.

The following is the step-by-step procedure to be used in cutting an external thread with a die.

Procedure:

1. Grind or file a slight chamfer on the end of the rod or pipe that is to be threaded. This permits the die to start easily.
2. Select the proper size die for the job and place it in the die stock.
3. Note the starting side of the die. (The side which has only partial threads cut in the hole.)
4. Place the stock in the vise, holding it in either a vertical or horizontal position.
5. With the starting side of the die facing the work, start the thread by turning the die stock slowly in a clockwise direction, keeping a firm pressure against the work. Care must be taken to hold the stock at a right angle to the axis of the work being threaded.
6. After the thread is "caught," squirt a generous amount of cutting oil over the die and work and continue turning the stock, backing off about one-quarter turn after every half turn, in order to break off chips.

If it is required to rethread a rod in order to produce a more perfect thread, care must be taken not to "cross-thread" the piece when starting the die. A "drunken" thread is caused by starting the die obliquely rather than square. Drunken threads are often the result of trying to start a die straight on a rod that was not cut off square.

Sinking a Well or Depression in a Tray.

To sink a well or depression in a tray, one of two methods may be used. A tray form may be used in which a depression is provided the exact shape and size required. This form may be made of metal or hard wood. The wooden form is not as permanent; however, it can be made up quickly for use if a wood turning lathe is available. Metal forms may be purchased at a metalcraft supply house.

A partial form may be used for the purpose of sinking a well in a tray. This form is usually made of maple or birch. It may be cut to the contour of the tray in order to obtain a uniform depth in the well. This method of sinking is usually used on trays of large diameters.

Forming a Tray in a Mold.

Procedure:

1. Select a tray mold of a desirable shape for the job on hand.
2. Measure the diameter of the recess in the mold and cut a circular disc of metal to fit exactly into this recess.
3. Select a wooden or leather-tipped mallet which will conform to the contour of the recess in the mold.
4. If the metal to be used is hard, anneal it.
5. Hold the disc in the mold with the left hand and start beating the metal with the mallet near the edge of the well.
6. The edge of the well will appear on the disc. This will provide a guide for directing successive blows.
7. Rotate the mold, beating the metal toward the side of the well, thus

FIG. 57. Sinking a well in a tray with a mallet

drawing the metal down into the well. (Do not beat metal on the bottom of the mold, direct the blows toward the side of the well, working gradually deeper in the form.)

8. Anneal the tray once for every quarter of an inch of sinking. Take care to keep the rim of the tray flat; use a rawhide mallet to flatten the rim if it begins to wrinkle.
9. When the well is sunk to the bottom of the mold, a piece of hard wood, formed to the shape of the contour of the well, may be used with a mallet to iron out irregularities in the tray.

Forming a Tray Using a Block of Wood Held in the Vise.

Procedure:

1. Prepare a block of hard wood cut to the shape of the contour of the well in the tray.
2. Drive two nails in the block to act as stops for the edge of the tray.
3. Cut a circular disc of metal the size required for the tray and anneal the disc, if necessary.

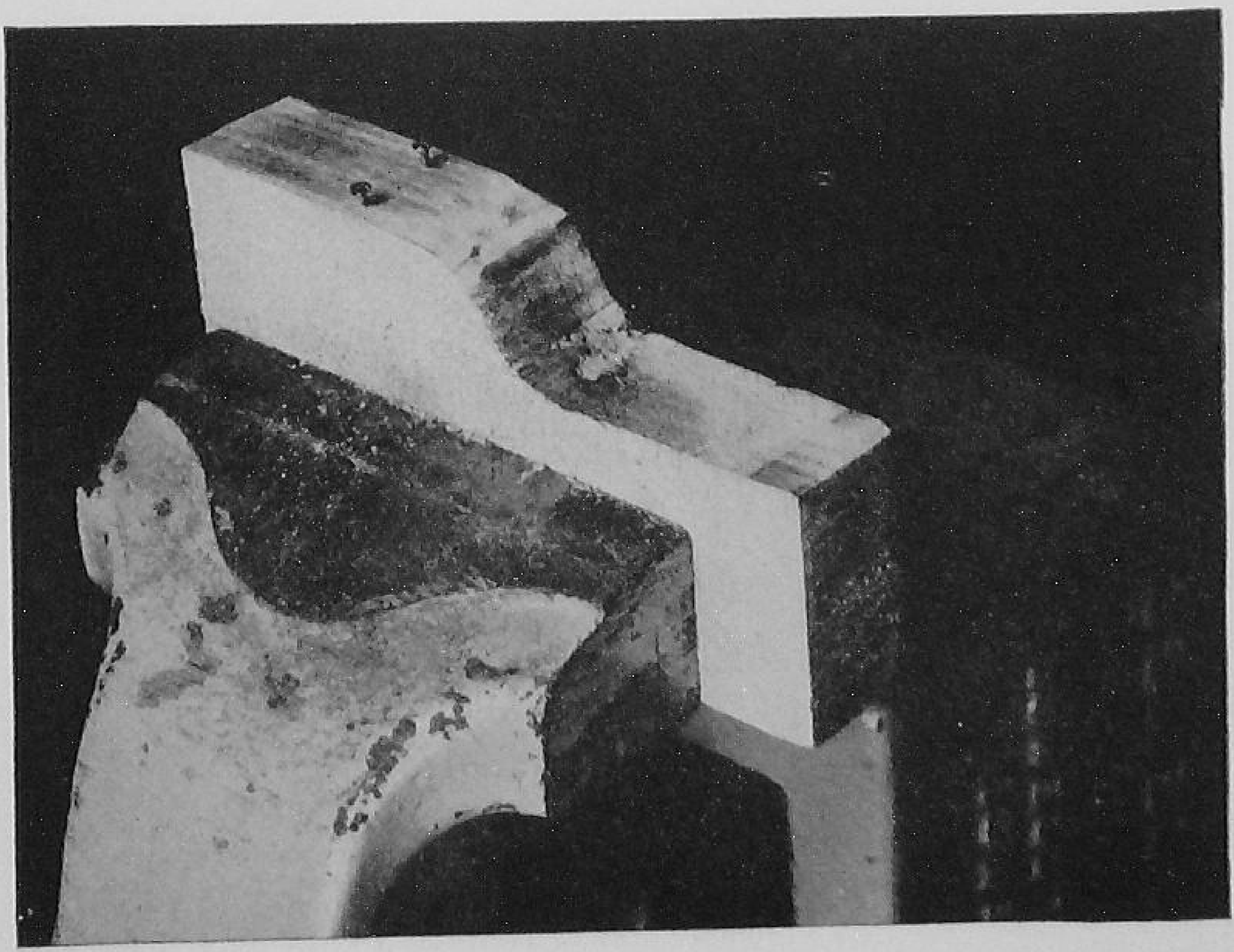


FIG. 58. Wooden stake used in sinking a well in a tray.

4. Scribe a circle on the disc as a guide to locate where the well begins.
5. Select a raising hammer whose shape most nearly fits the shape required.
6. Hold the disc in the left hand and strike lightly just inside the well line, rotating the disc slowly.
7. Turn the tray upside-down on the bench and straigthen the rim using a block of hard wood and a mallet.
8. Anneal the tray as required.
9. Repeat the sinking until the well is the required depth.

Fig. 59. Sinking a well in a tray using wooden stake.

Raising a Bowl.

A bowl is one of the most useful and ornamental objects made in the metalcraft shop. Raising is the process of forming a bowl from a flat disc of metal by beating it into a shallow depression formed in the end grain

of a block of wood or by forming it over a stake, using a raising hammer or mallet. For the beginner, it is advisable to limit the design and size of the bowl in order to first master the process of low raising. A bowl made from a disc not more than 6″ in diameter is not too difficult for a beginner to attempt. The art of raising a bowl, unlike most work in metal, does not necessarily limit a person to exacting dimensions. The design often is developed while working on the metal, much as the potter forms the clay on a potter's wheel. However, the beginner should limit the depth of the bowl to one-third the diameter of the original disc and the contour should conform to a curve on a planishing stake in order that the planishing may be done with ease. For a description of planishing see page 357.

Raising a Shallow Bowl.

In shallow raising, the material for the depth is secured by stretching the metal in the raising process. The metal becomes thinner as the bowl becomes deeper. It is therefore good practice to use a fairly heavy gage metal for this type of work. In this process, because of the stretching, the diameter of the original disc need be only slightly more than the diameter of the top of the finished bowl.

Procedure:

1. Cut the circular disc.
2. Anneal the disc.
3. Form a slight hollow by beating a depression in the end grain of a block of hard wood or on the surface of a rectangular block of lead with a raising hammer.
4. Clamp the block in a machinist's vise and start to raise the bowl, using a ball peen hammer or a raising hammer; begin raising along the outer edge. Rotate the disc while hammering and strike the metal with even blows.
5. Anneal the metal as it becomes hard and unyielding. Annealing is usually necessary once for each ¼″ of depth obtained.
6. Work in concentric circles toward the center of the disc. More depth may be obtained by repeating the above operations. Smoothness is not of major importance; however, care must be taken to maintain a uniform shape.
7. Correcting the uniformity of contour may be done by directing hammer blows at flattened areas. Deep indentations may be removed by

inverting the bowl on a stake and hammering these dents out with a wooden or rawhide mallet.

8. The bowl is now ready for *finishing* or further shaping such as *flaring, fluting,* or *bottoming*. These processes are explained in another section of this chapter.

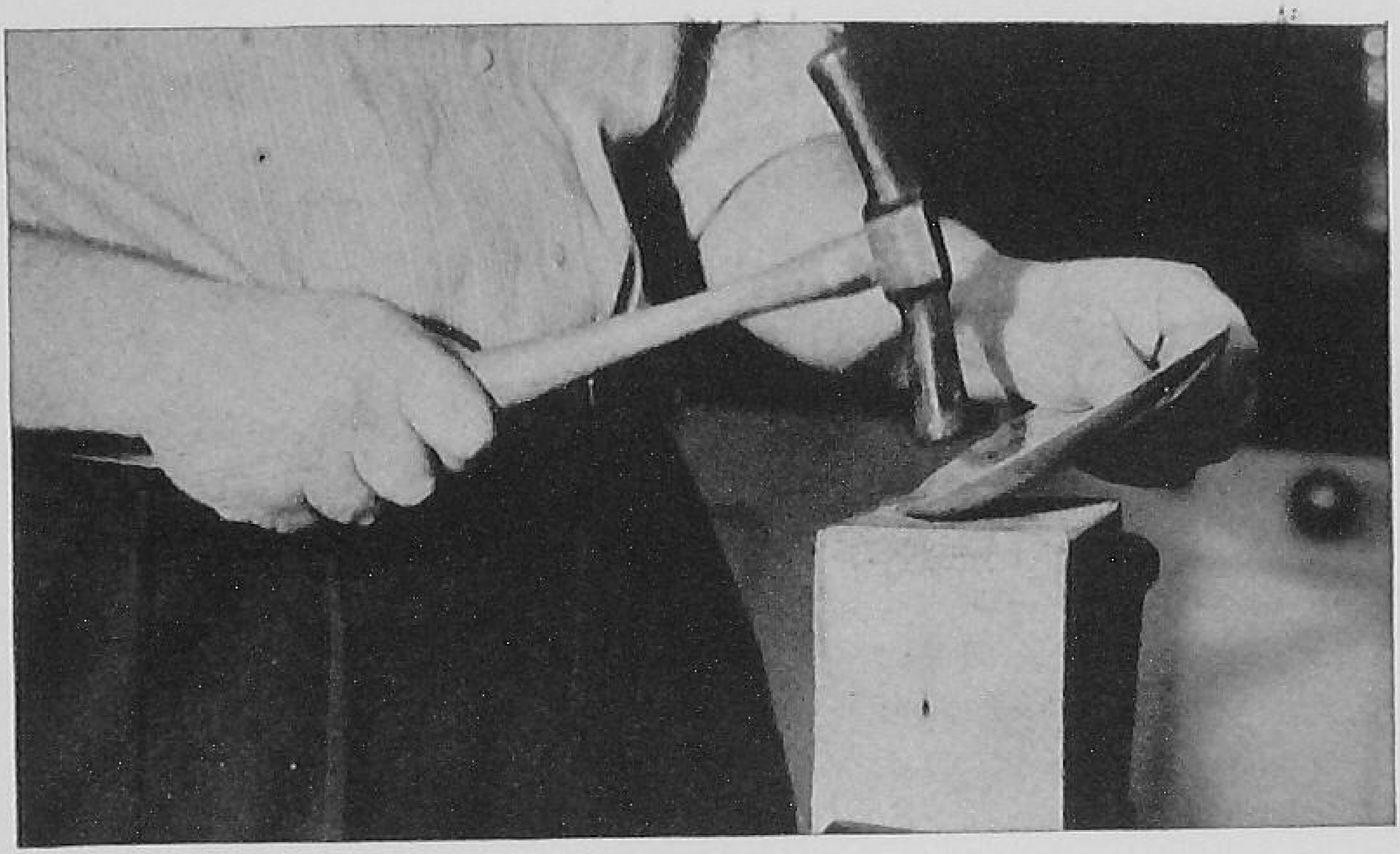


FIG. 60. Raising a bowl using a raising hammer and a block of hard wood.

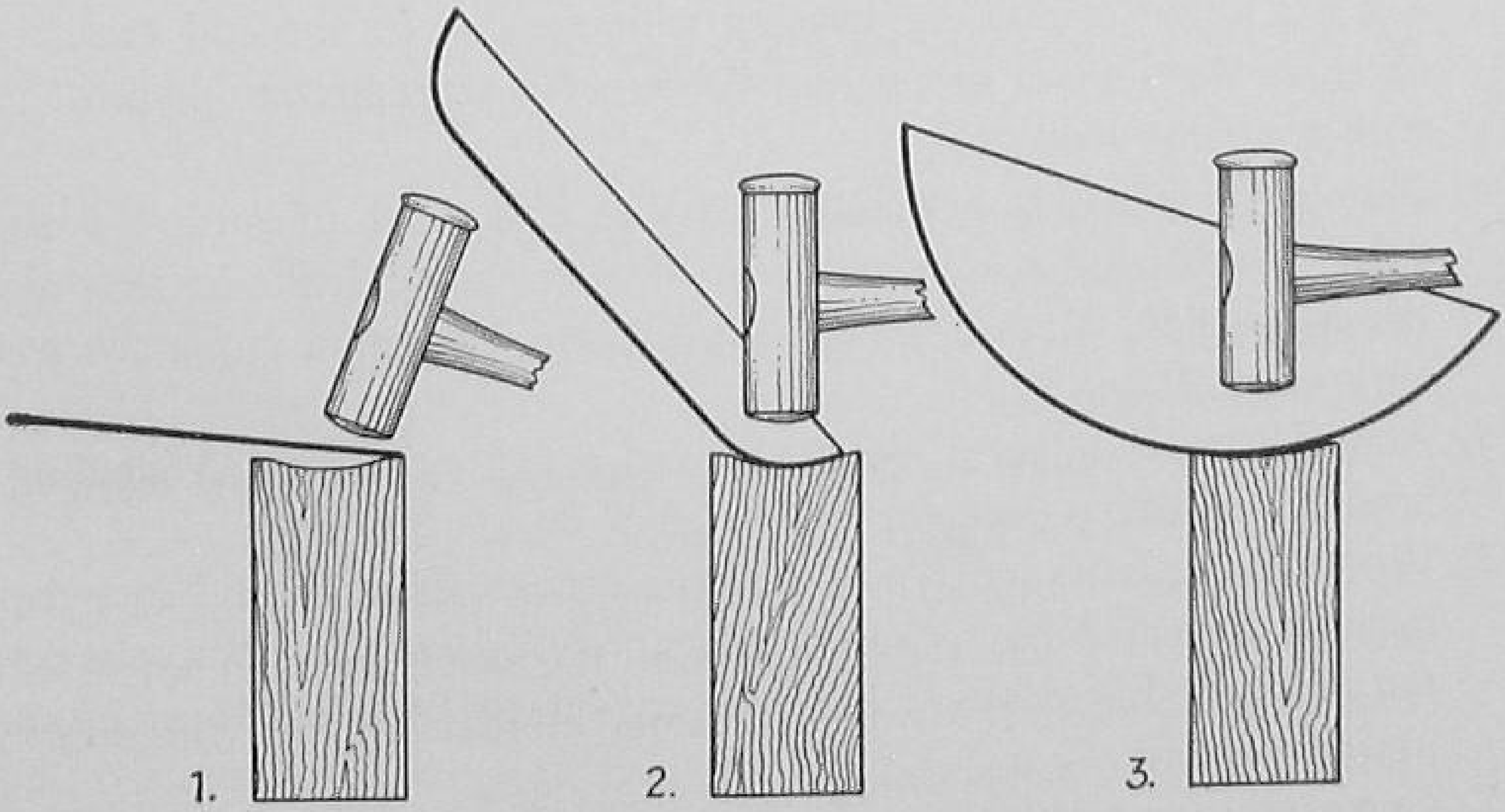


FIG. 61. Steps in raising a shallow bowl using a raising hammer and a block of hard wood.

Raising a Deep Bowl.

Deep raising is a method of shaping a hollow vessel of greater depth than that described above. In this process, most of the hammering is done on the outside of the vessel and the metal is not thinned as it is in sinking or shallow raising. The diameter of the disc required is determined by adding the height of the vessel to the largest diameter. The beginner should limit himself to a beginning disc of not more than 6″ or 7″ in order to master the techniques before attempting something more difficult. The process of planishing may be simplified if the shape of the vessel is made to conform to the contour of a single stake that is on hand in the craft shop.

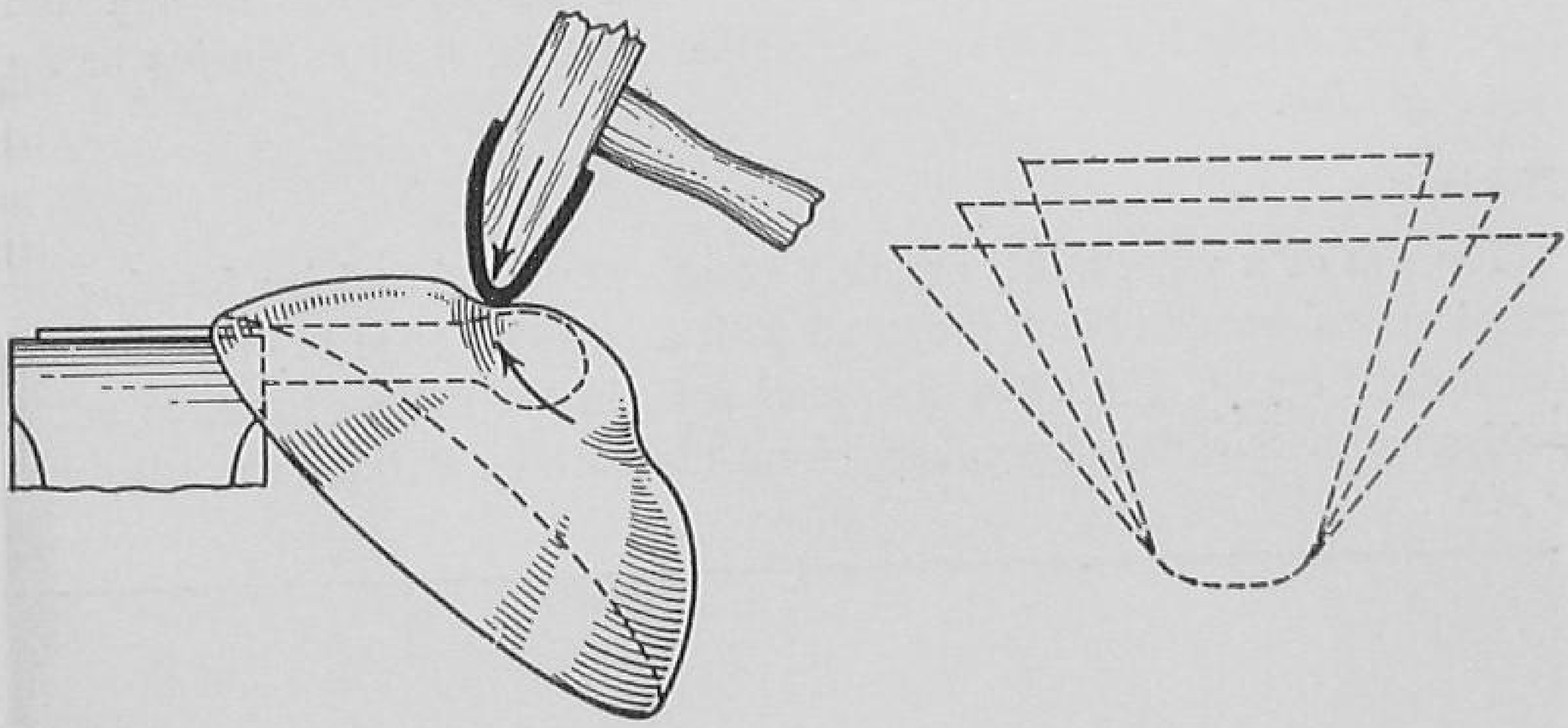


FIG. 62. Raising a deep bowl over a stake.

Procedure:

1. Cut a circular disc of the diameter required.
2. Anneal the disc.
3. Begin to raise the disc as described in the preceding process: "Raising a Shallow Bowl."
4. Clamp a "T" stake horizontally in the vise and hold the work over the end of the stake at a slight angle.
5. With a raising hammer or a wedge-shaped wooden mallet, strike the metal slightly above the point where the metal makes contact with the stake. Rotate the work, forming the metal, above the point of contact, down on the stake.
6. After one rotation, continue a second course by moving the work and directing the blows slightly above the first course.

Caution: Frequent annealing is essential. The work cannot be raised too quickly as crowding of the metal will cause cracks. If cracks appear they may be soldered with a hard solder which does not discolor the copper.

7. It is a good plan to mark a circle around the vessel after each annealing to guide the hammer blows for the next course.
8. On the last course, where the metal is driven down directly on the stake, a wooden mallet is used instead of a hammer.
9. After the top course is reached, the vessel may be corrected by testing its contour with a template made from a piece of stiff cardboard, and by forming areas which do not conform to contour of the template.
10. The vessel is now smoothed over a stake, using a fiber mallet. It is then ready for *planishing* or further shaping such as *flaring* or *bottoming*.

Flaring.

The rim of a vase, bowl, or other vessel may be flared by forming the metal over a wooden block prepared with a rounded edge to conform with the desired curve. Place two flat-head nails in the flaring block to act as guides for the metal and gradually form the flare by striking the edge with

Fig. 63. Flaring the edge of a bowl.

a rawhide or leather-tipped mallet. Rotate the work on the wooden stake as the blows are directed on the edge of the work. Annealing must be done as soon as the metal does not yield to the action of the mallet. In flaring as in raising, if the bowl is to be finished by planishing, one must keep in mind the shape of planishing stakes which are available and work to a curve that will fit over the planishing stake.

Planishing.

Planishing is the process of producing a series of highly polished facets on a metal surface by striking the surface of the metal, as it is being held on a planishing block or stake, with the highly polished face of a planishing hammer. Planishing hardens and stiffens the metal; therefore, it enables the object to retain its shape better. The size of the facet produced by planishing depends on the radius of the face on the planishing hammer and the curvature of the work. Usually a planishing hammer has one face with more of a spherical curve than the other. Some planishing hammers have a face which is absolutely flat. This face is only for planishing work which has a convex surface.

Good results in planishing depend to a great extent on preparation of the work and tools. The work must be cleaned thoroughly before planishing. It is not necessary to remove deep scratches; however, the work should be pickled and all loose scale from all surfaces must be removed with steel wool. The planishing hammer, stake, or block must be polished to a mirror-like surface. Any imperfection in the surface of the planishing hammer, stake or block will imprint itself in every facet that is made with the hammer.

Preparing the Planishing Stake, Hammer, or Block.

Procedure:

1. Clamp the tool whose planishing surface is to be polished, in a machinist's vise.
2. Remove deep scratches with No. 120 grit abrasive cloth, working the cloth over the surface in the same manner as you buff a pair of shoes. Use a bit of cutting oil on the abrasive to help the polishing action.
3. When the deep scratches have been removed, follow with a piece of No. 180 grit abrasive cloth. Polish until the scratches made with the No. 120 grit have disappeared.
4. Continue with No. 240 abrasive and then repeat with No. 320 abrasive cloth.

5. Bring the surface to a mirror-like polish with a piece of crocus cloth or polish the surface on a buffing machine using a felt wheel and jeweler's rouge.
   Note: Care must be taken to remove all deep scratches with the coarser abrasives before advancing to the finer.

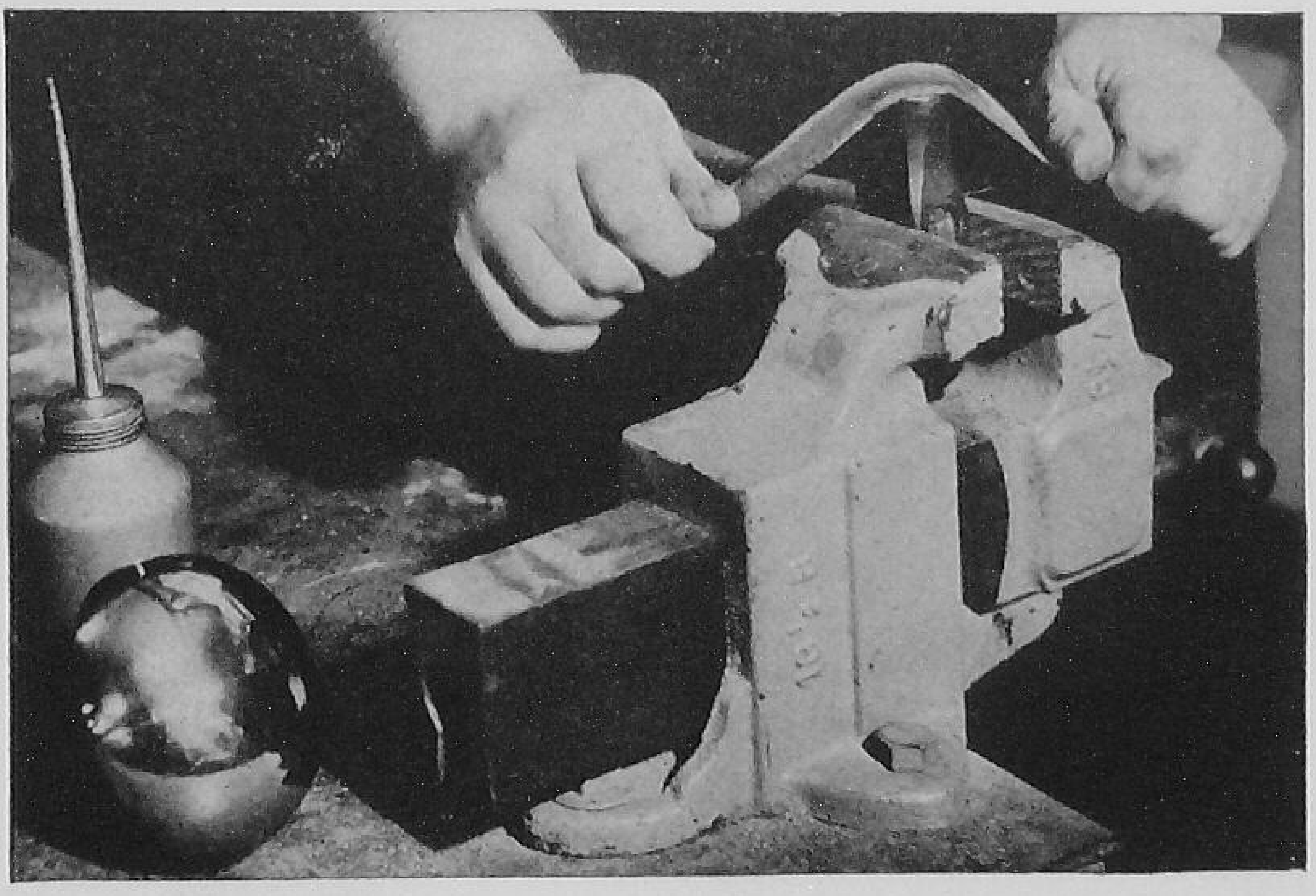


FIG. 64. Repairing planishing hammer and stake.

Planishing.

Procedure:

1. Select a stake which most nearly conforms to the contour of the work. (Flat work is planished on a flat planishing block.)
2. Select a hammer and try it out on a scrap of metal to determine the size of the facet produced.
3. Polish the hammer and stake as outlined above.
4. Clean the metal of oxides by pickling and cleaning thoroughly with steel wool.
5. On circular work, start in the center and planish in concentric circles, working toward the outer circumference.
6. Take care that the metal is held in contact with the stake at the point where the hammer is to strike. The hammer should hit th

metal squarely in order to avoid unsightly marks from the corner of the hammer. The facets formed by the hammer should be uniform and should overlap slightly.

7. Clean the planished surface with fine steel wool and inspect it for "holidays" (places which have been overlooked). Replanish the surface in areas where necessary.

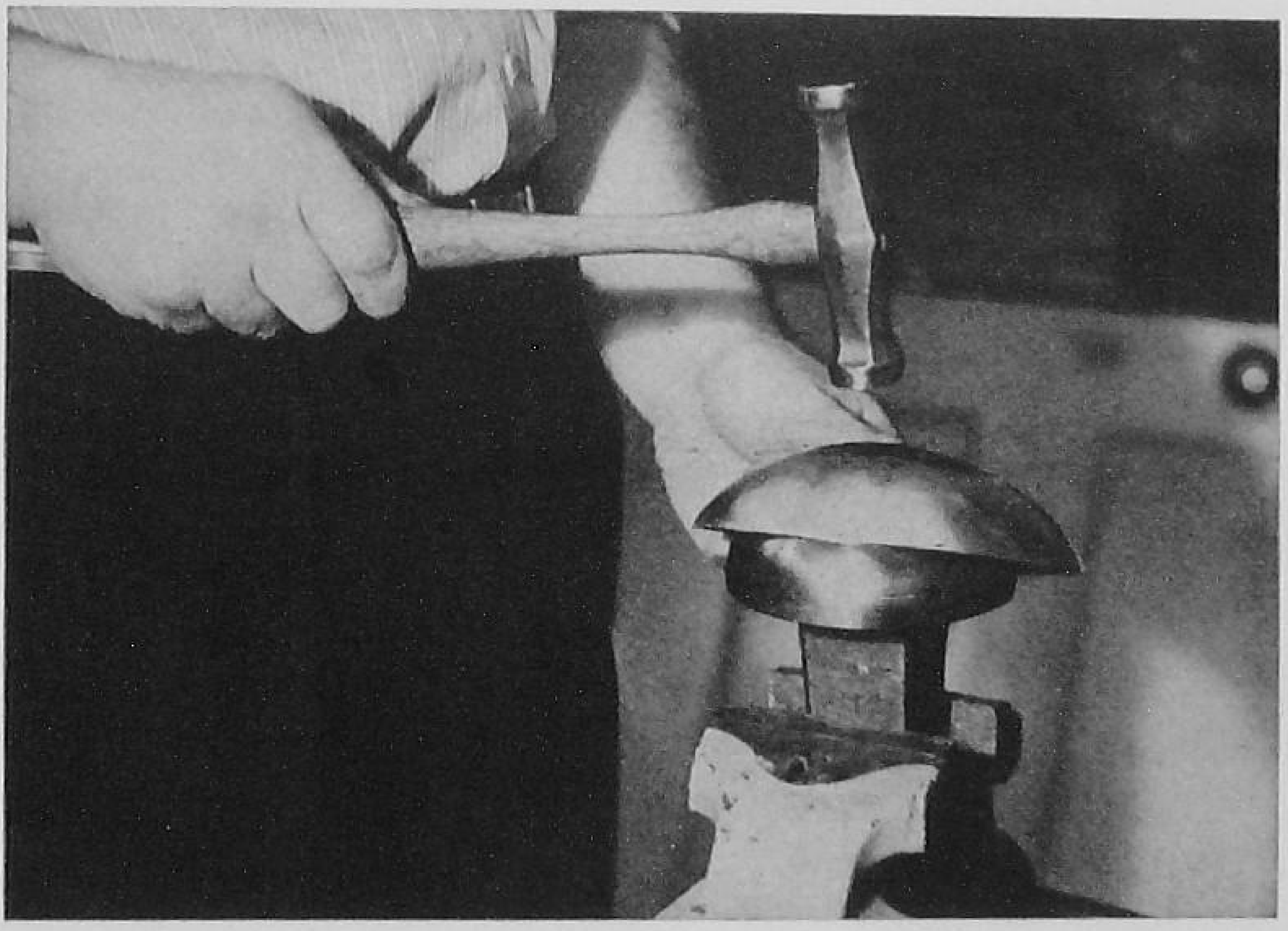


FIG. 65. Planishing over a stake.

Planishing may be done with a ball peen hammer if the ball is properly prepared. The small facets produced by the ball peen hammer, however, require more work in hammering and therefore are not satisfactory for large areas. Normally, it is not necessary to anneal the work during or after the planishing operation.

Fluting.

An effective method of decorating a shallow bowl or the rim of a plate or tray is by fluting. Fluting is the process of embossing shallow, straight-lined, radial depressions in a piece of metal. When the flute is depressed from the outside of the bowl or the bottom of the rim of a plate or tray, it

is known as concave fluting. Work that is fluted in the reverse is called convex fluting. In general, it is easier to prepare tools for concave fluting.

Before the fluting is done, a fluting block is made of a piece of maple or other hard, close-grained wood. This block is formed to fit the contour of the work. A V-shaped groove is filed in the block to the depth required. A wedge-shaped fluting tool is prepared of hard wood. This tool is used to drive the metal down into the groove.

Procedure:

1. Divide the circumference of the work into any number of equal parts as required.
2. Draw radial lines on the outside of the work with a pencil, indicating the location of flutes.
3. Place the fluting stake in a machinist's vise.
4. The work is held in position on the stake, lining up the groove in the stake with the pencil mark on the work. (This requires the assistance of a second person.)

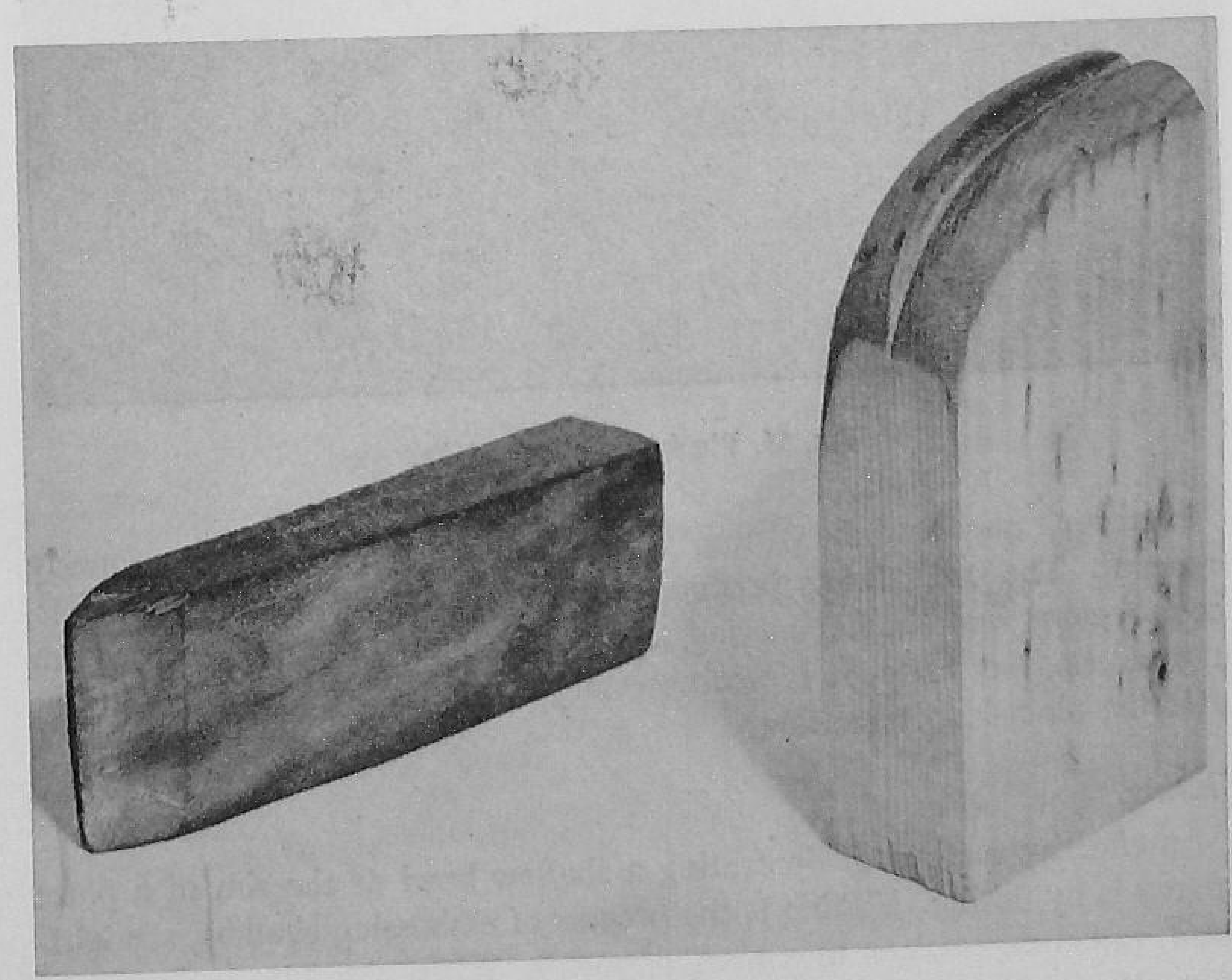


Fig. 66. Fluting tools.

5. Holding the wedged tool in the left hand and a hammer or mallet in the right, the metal is driven into the groove in the stake (Fig. 67).
6. The above operation is repeated on the remaining radial lines, taking care to make each of uniform depth and size.

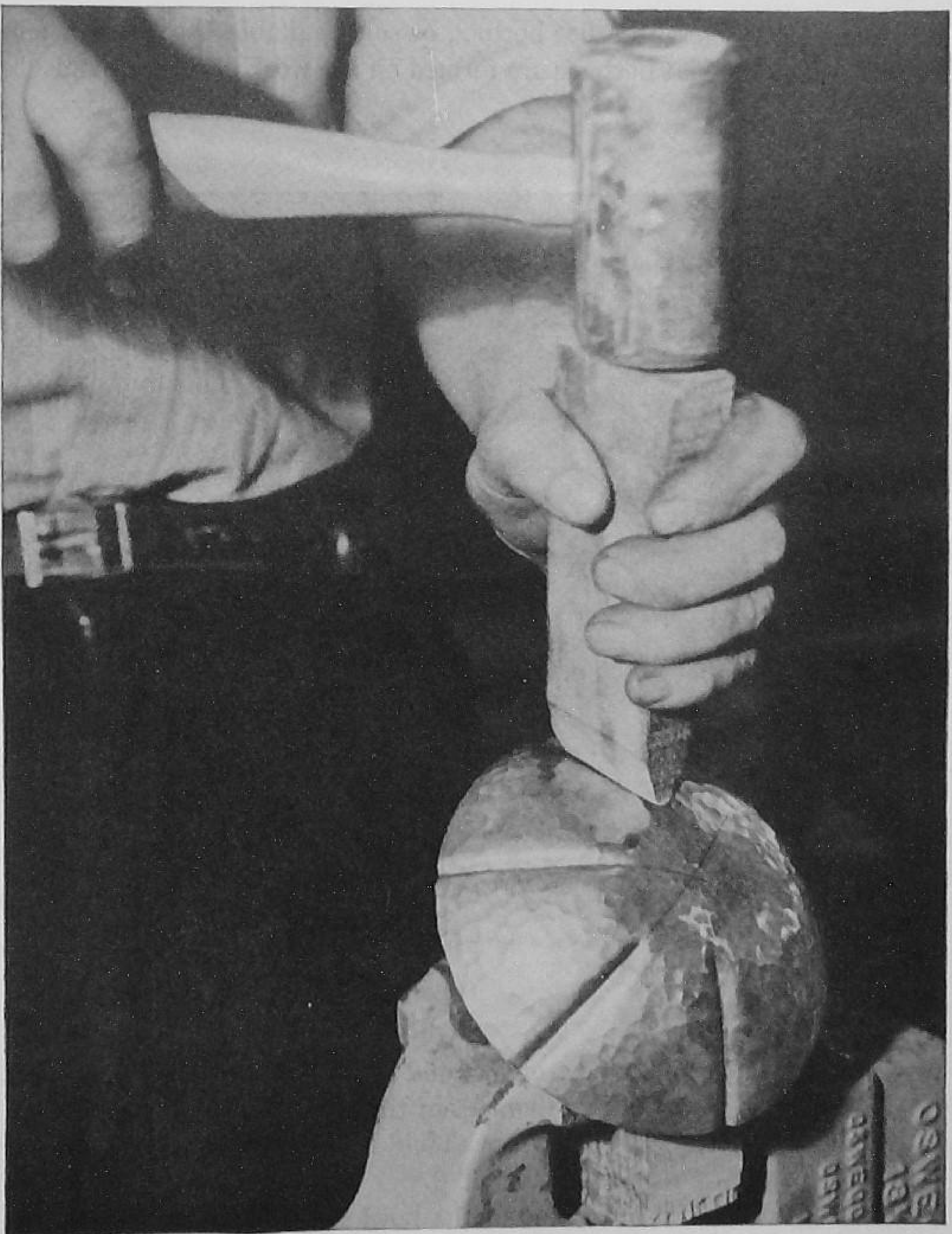


Fig. 67. Forming the flutes.

Note: Fluting seldom requires annealing and may be done directly after the planishing or bottoming operation.

Bottoming.

In order for the bowl, tray, or vessel to set in position on a flat surface, it must be provided with a flat bottom, or some suitable base or foot must be fastened to it. Flat bottoms are formed on the work after the planishing operation.

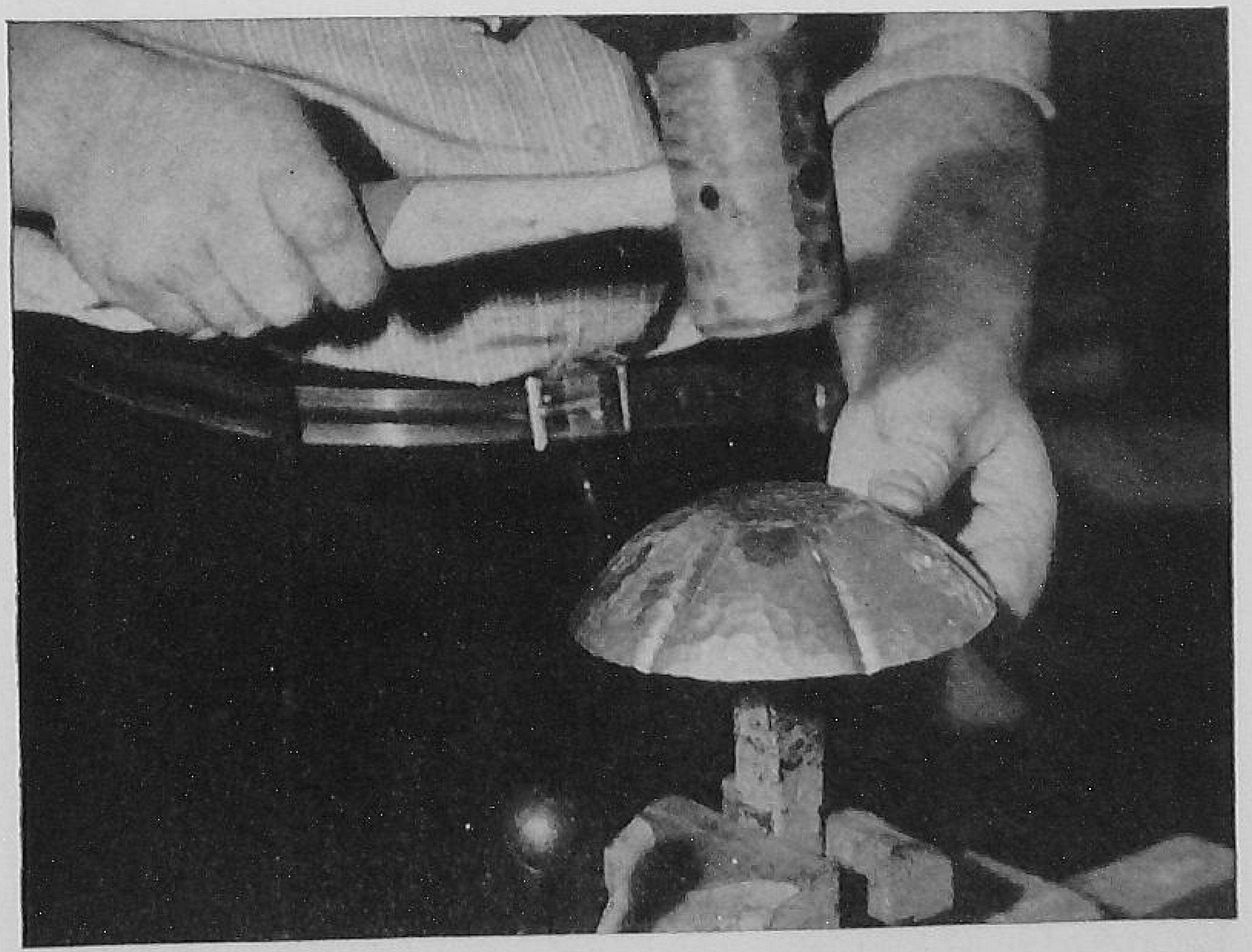


FIG. 68a. Flattening the bottom.

Procedure:

1. Select a bottoming stake or a round piece of cold-rolled steel whose diameter is equal to the diameter of the bottom as required. If cold-rolled steel is used, the surface should be smooth, and the sharp corners should be rounded with a file.
2. Mark a circle on the inside of the bowl representing the bottom.
3. Place the work on a sandbag, hold the bottoming stake in place, and

strike the stake with a mallet in order to mark the bottom circle on the outside surface.

4. Place the stake in a machinist's vise, invert the bowl on the stake, and flatten the bottom using a rawhide mallet. Take care to hold the bowl in place as indicated by the mark from the previous operation.
5. A bottom shoulder is formed with a sharp wedge-shaped mallet, or a necking hammer striking the work slightly outside the stake edge.

Fig. 68b. Forming a shoulder on the bottom.

Trueing Up.

After the forming has been completed and the bottom is formed or the foot is fastened to the bowl, the irregular top edge is "trued up" so that it will set level. This is accomplished by holding the object securely on a flat metal plate and, with a surface gage adjusted to the proper height, a line is scratched around the work near the top. The excess metal is then trimmed off with a pair of snips and the edge is finished with a file. An effective substitution for a surface gage may be made by using a pencil and a block of wood of the proper height.

Repoussé Work or Chasing.

Chasing is a means of decorating metal work to give it a tooled effect. The work is done on the reverse side of the material, for the most part, by means of chasing tools which are made in many shapes and forms. *Repoussé,* as chasing work is often called, is an art which was mastered by metalcraftsmen in early history. It is sometimes referred to as sculpture work in metal, as it gives the flat surface of sheet metal a three-dimensional effect.

Chasing is discussed in the Section on Hand Made Jewelry.

Chasing tools of various sizes and shapes have been discussed in Chapter 2; however, it might be a good plan for the beginner to make himself a few of the more common tools for his own use. A drawing and directions for making these tools are included in the following chapter.

The procedure used in chasing is similar to that used in the tooling of metal foil, the main difference being that the metal used in chasing is heavier than the foil and therefore requires more pressure to shape it. Simple designs, such as flowers or leaves, lend themselves to this three-dimensional modeling. The metal is held in chaser's pitch which may be kept in a metal pan or, for small work, the pitch is held in a semi-spherical pitch block which is held in a chaser's ring. The chaser's ring is a metal or leather ring which enables the chasing block to be held in various positions while the chasing is being done. As in other fields of metalcraft work, chasing requires a great deal of practice. The beginner should limit himself to simple designs on small work. For most work, No. 20 B & S gage soft copper is satisfactory. The work is usually done on a piece slightly larger than the design and trimmed after it is removed from the pitch; however, this is not always the practice.

Polishing and Finishing Metals.

Buffing. The nonferrous metals used in the metalcraft shop are usually polished to a mirror-like luster on a buffing lathe; however, in order to produce a good polished finish on any metal surface, the underlying principle of polishing must be understood. One may consider the polishing operations as beginning with the final pickling and cleaning of the metal which prepares the surface for planishing. Planishing is a surface-finishing operation which in turn leaves only minor imperfections which may be removed on the buffing lathe.

Procedure:

1. If the surface has been oxidized by heating, pickle the metal after its last heating. (See *Pickling procedure.*)
2. Clean the oxides off the metal with steel wool or pumice stone.
3. If work is to be planished, planish the surface. (See *Planishing procedure.*)
4. If the work is to have an unplanished, polished surface, remove deep scratches with a coarse abrasive cloth starting with an abrasive coarse enough to remove the deepest scratches. Remove the marks made with the coarse abrasive with the next finer abrasive thus grading the abrasives used from coarse to fine, removing abrasive scratches made with one grit, with the next finer grit. Do not try to remove deep scratches with too fine an abrasive. The abrasive equipment may be stored in an envelope for reuse at a later date. It is not necessary to polish planished surfaces with abrasive cloth as the planishing should remove all the deep marks from the surface of the metal.
5. Nonferrous metals may be polished further by using a fine and extra-fine grade of steel wool.
6. Select a coarse muslin buffing wheel for the buffing lathe and screw it on the taped arbor. (Notice that the left-hand arbor of the buffing lathe has a left-hand thread which allows the buffing wheel to advance on the arbor as it is rotated counterclockwise.)
7. Protect your eyes and face with an eyeshield or goggles.
8. Start the machine and apply a coarse buffing compound to the *bottom* of the revolving wheel. *Emery paste* is especially good for polishing iron or steel; *Tripoli composition* is good for preliminary polishing of copper, brass, bronze, German silver, and other nonfer-

rous metals; *white diamond dust composition* may be used on the above metals when only one buffing operation is to be used.

9. A hard felt wheel may be used on certain work where a considerable amount of "cutting down" is necessary. Any of the above compounds are used on the felt wheel.
10. If it is desired to produce more of a luster on the polished surface, a fine, loosely stitched cotton buff is placed on the machine. This fine buff is used only with jeweler's rouge compound and should be kept free from all other abrasives. Buffing with this compound is the final polishing operation and will not remove scratches. Its action is a rubbing action rather than that of cutting or scratching.

Too much polishing compound on the wheel will cause the wheel to deposit some of the compound on the surface of the work. Too little pressure will produce the same effect. Care must be taken to allow the rotating wheel to work off the edges of the metal. If the wheel is allowed to run onto the edge of the metal, the work will catch and may be thrown from the wheel.

Various scratch brushes may be used on the buffing lathe in order to produce finishes such as a *brush finish, satin finish* or *matt surface*. These finishes depend on the size of the wire in the brush and the material which is used for the wire in the brush. No compound is used with these brushes.

Preserving the Surface. Most metals are affected by the action of various gasses in the atmosphere. Highly polished copper and brass will discolor rapidly and should be protected with a good grade of metal lacquer. Other highly polished metals may either be lacquered or waxed. A good grade of paste wax is effective for use on surfaces which are chemically colored. A decidedly more permanent result may be obtained by applying one or more coats of a good grade of metal lacquer. If the surface is waxed, it may need to be renewed in two or three weeks.

Lacquering. Clear metal lacquer may be applied to metal surfaces to prevent oxidation. In order to obtain best results, a fine ox-hair, sign painter's brush may be used. The metal must first be washed, preferably with lacquer thinner and allowed to dry without touching its surface with the fingers. Lacquer, as it comes from the can is generally too thick for immediate use and therefore should be thinned so that it will flow freely as it is brushed on the surface. Lacquer must be brushed on quickly and should not be gone over with the brush after it is applied, as it becomes tacky almost immediately. Care must be taken to spread the coating evenly on the surface and not to leave any "holidays" which will tarnish quickly

and produce an unsightly dark mark on the surface. If you are not satisfied with the results at the first attempt, remove the lacquer with *lacquer thinner* and repeat the operation. Lacquered work cannot be repolished unless all the lacquer is first removed with its solvent. Lacquer usually dries enough for light handling in fifteen or twenty minutes.

Chemical Finishes.

Oxidized Surface. Perhaps the simplest chemical means of coloring a surface is to heat the metal and allow the oxygen in the air to form a layer of oxides on the surface. The surface of the metal must be cleaned by buffing or with steel wool and oil or grease must be removed with soap and water or some other grease solvent before this process is attempted. As the temperature is raised, the colors change, beginning with a pale yellow and changing progressively through brown, purple, and blue to a dull varigated surface. Practically all metals may be colored in this manner, but some of the colors are very hard to preserve. The surface must be protected by wax or lacquer after the desired color is obtained. Some experimentation with sample pieces will be necessary to obtain the desired effect. It will be found that the wax or lacquer will affect, and in some cases entirely change, the color produced by heating.

Antiqued Surface. An excellent antique effect may be obtained on copper, brass, and German silver by mixing a small amount of *liver of sulphur* with water. This solution may be applied either hot or cold with a brush or a swab made by twisting a bit of cotton waste about a stick of wood. Be sure that the surface of the metal is clean. It is a good plan to test the solution on a scrap piece of metal and then add more water or liver of sulphur as needed. Highlights may be rubbed on the surface with very fine steel wool after the work is dry. The work is then protected with wax.

Other chemical coloring agents for various metals are listed below. The chemicals may be bought at any drugstore.

As the proportions given for the solutions are more or less theoretical, the following round figures, which are easier to remember, may be used:

30 grams = 1 ounce
1 liter = 1 quart

To Color Copper or Brass Green or Antique Green

Cupric nitrate	$Cu(NO_3)2$		40 grams
Ammonium chloride	NH_4Cl		40 grams
Calcium chloride	$CaCl_2, 2H_2O$		40 grams
Add distilled water	H_2O	To make	1 liter
Brush onto a clean surface.			

To Color Copper Blue or Purple

Sodium hyposulphate	$NaHSO_2$		60 grams
Nitric acid	HNO_3 (Conc.)		4 grams
Add distilled water	H_2O	To make	1 liter
Dip metal into this solution.			

To Color Copper Black

Potassium sulphide	K_2S		15 grams
Ammonium chloride	NH_4Cl		200 grams
Add distilled water		To make	1 liter
Dip metal into this solution.			

To Color Iron or Steel Black

Sodium thiosulphate	$Na_2S_2O_3$		3 grams
Add distilled water.	H_2O	To make	1 liter
	(Temperature of solution 200° F.)		

To Color Iron or Steel Blue

Sodium bisulphite	$NaHSO_3$		60 grams
Lead acetate	$Pb(C_2H_3O_2)_2$		15 grams
Add distilled water	H_2O	To make	1 liter
Dip metal into this solution.	(Temperature of solution 200° F.)		

Miscellaneous Finishes.

Polished surfaces on iron or steel are usually obtained by a process of draw filing and then polishing with emery cloth wrapped around the file to provide an even pressure. Oil is often used with fine emery cloth for the final finish. For a good luster after all the scratches have been removed, crocus cloth is used in the same manner as emery cloth.

Steel wool may be used to impart a fairly bright finish to the softer metals such as aluminum, pewter, and lead. The finer the steel wool the smoother will be the finish.

An attractive dull satin finish may be obtained by rubbing the metal surface with a coarse brush dipped in a mixture of pumice and water.

The circular spotted finish often seen on metal surfaces may be produced by the use of a wooden or fiber rod held on the chuck of the drill press. The end of the rod is charged by dipping into a mixture of fine emery and oil, and the revolving rod is brought down on to the metal surface to form a regular pattern of spots.

PROJECT 1

Galley Ship Plaque

This plaque makes an interesting subject for metal foil tooling.

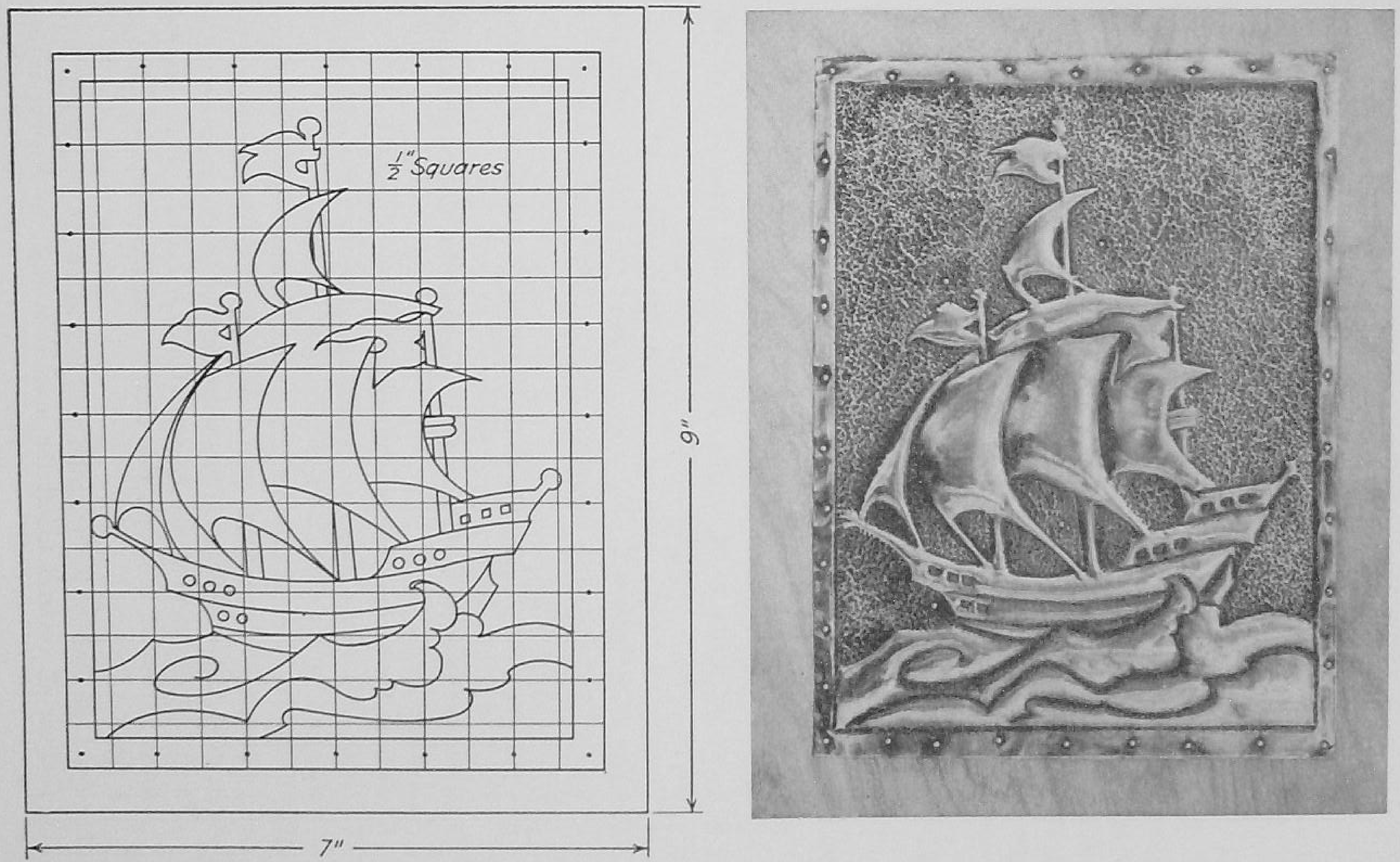
Material:

1 pc. Copper or brass foil, 32 or 34 gage, 6″ x 8″
28 ⅜ #18 brass escutcheon pins
1 pc. ⅜″ plywood, 7″ x 9″

Procedure:

1. On squared paper, make a full-sized drawing of the galley ship.
2. Obtain a piece of 32 gage copper or brass 6½″ x 8½″.
3. Using carbon paper, trace the design on the copper.
4. Raise the design as explained in Chapter 3.
5. Fill raised portions with plastic fill.
6. Prepare a piece of plywood 7″ x 9″ and sand the edges.
7. Stain the wood if desired, and apply two coats of shellac.*
8. Fasten metal foil to the wood backing with escutcheon pins.
9. Clean the metal foil with very fine steel wool.
10. Lacquer or antique the surface as desired.

* See *Woodworking Crafts,* Van Tassel, R., D. Van Nostrand Co., New York, 1947.



Project 1.

Bracelet

A bracelet is an excellent object for a beginner in craft work. Although the design may be pierced into the metal, the most satisfactory process of decorating the surface is by *etching*. The designs illustrated on the opposite page are suggestions for an etched design. Any of these, or any other "area type" designs which require little detail work with the brush, will be satisfactory for the beginner. The size of the bracelet blank is determined by making a stiff paper pattern and trying it on the wrist. The ends should be open enough to allow the bracelet to be removed without the necessity of bending.

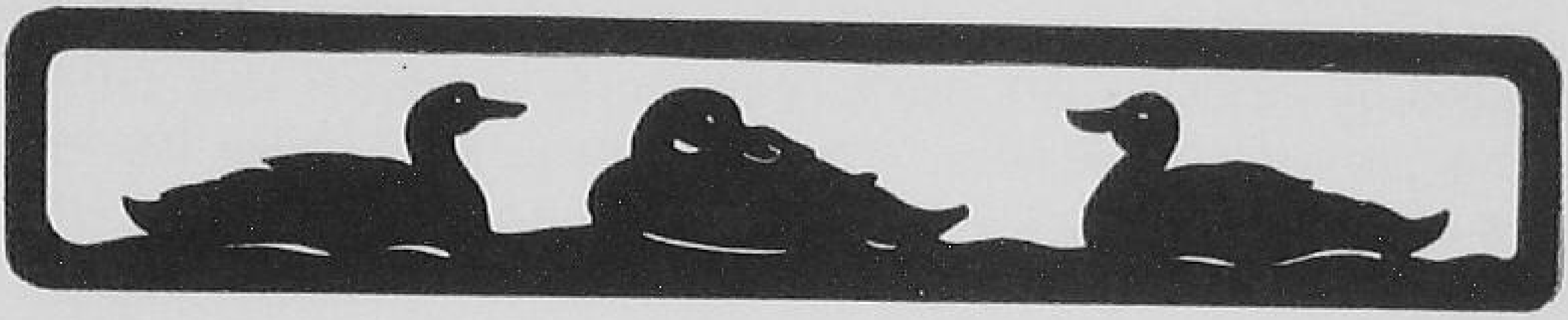
Material:

18 B & S gage hard copper, German silver, brass, or sterling silver.

Procedure:

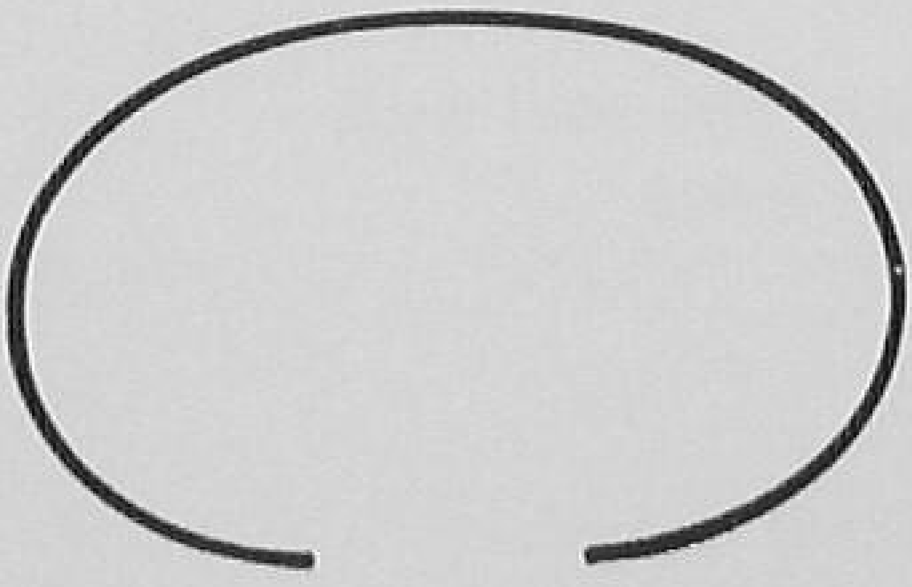
1. Make a pattern of the bracelet to determine length and width.
2. Prepare a rectangular blank the proper size.
3. Select the design to be used on the surface and trace or draw the design full-size on a piece of paper.
4. Transfer the design on to the prepared blank. (See Chapter 3).
5. Clean all surfaces with steel wool and paint the surfaces which are not to be etched with asphaltum paint. (Allow the acid resist to dry at least 12 hr.)
6. Place the bracelet blank in the etching solution and allow it to etch about $\frac{1}{64}''$ below the original surface.
7. When the required depth is obtained, remove the blank and rinse it in water.
8. Remove the asphaltum with turpentine.
9. If the ends of the blank are to be curved, cut the curve with *aviation snips* and smooth all edges with an 8″ mill file.
10. If care has been taken in polishing the blank before it is etched, a pleasing effect is produced with no further polishing necessary. The bracelet in the illustration has been finished in this manner. If a high luster is desired, the bracelet blank is buffed. If an antique finish is desired, the surface is cleaned and the antiquing solution is applied.
11. Bend the bracelet to the shape indicated in Figure D, Page 375.
12. Lacquer all surfaces unless the bracelet is made of sterling silver.

A



B

C



D

Project 2.

PROJECT 3

Coaster

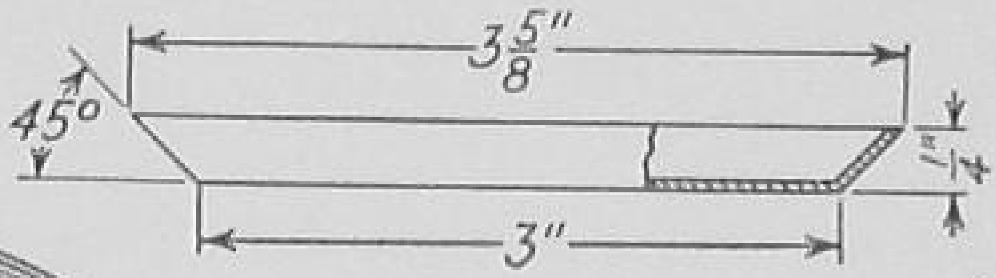
A coaster or set of coasters may be made in the metalcraft shop with a minimum amount of equipment. The special stake for forming the rim may be made by chamfering a 4″ diameter piece of cold-rolled steel or a suitable form may be made of hard wood in the wood-turning lathe. If no special stake is available, a satisfactory beveled rim may be made on a blank of metal by merely forming the bevel with a mallet over a 3″ diameter bottoming stake.

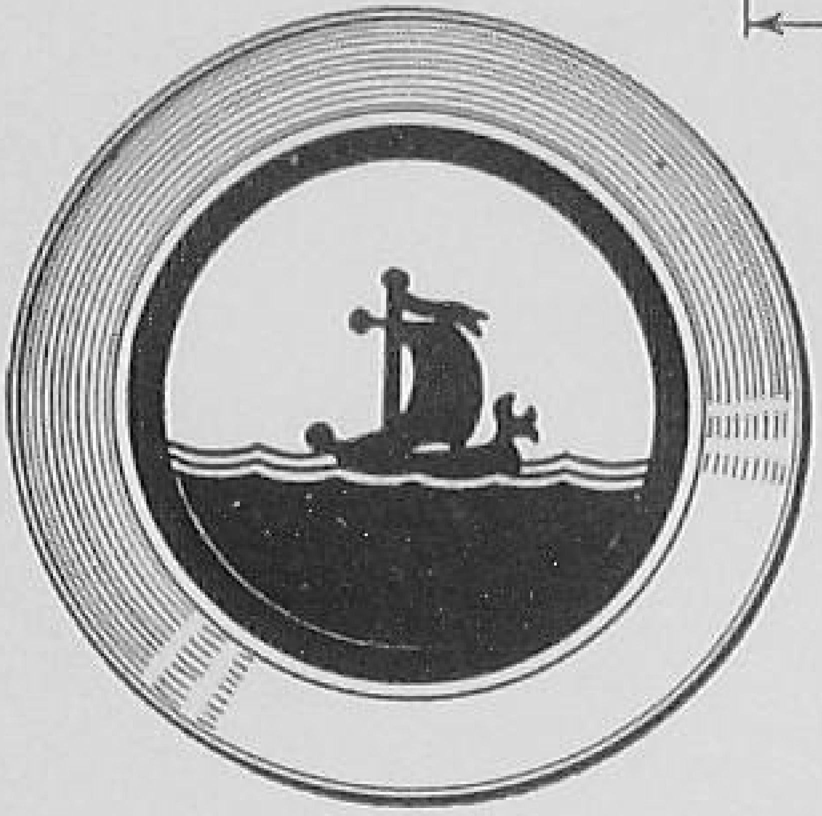
Material:

18 gage copper, brass, or aluminum 3¾″ D

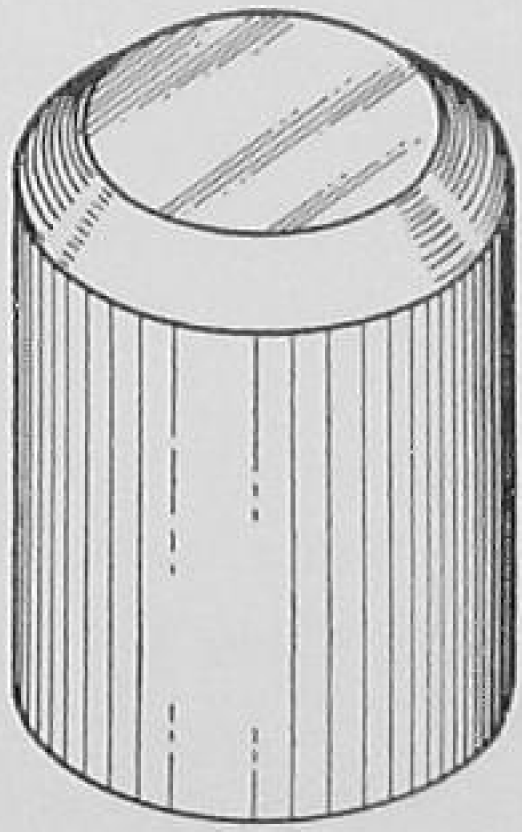
Procedure:

1. Cut out the circular disc blanks.
2. Form the bevel over the special stake or a 3″ D bottoming stake. (use a rawhide mallet.)
3. Anneal the metal if necessary.
4. Pickle the blank and clean it thoroughly with steel wool.
5. Transfer the design to be etched on the metal.
6. Paint the design with acid resist.
7. Etch the design about $\frac{1}{64}$″ deep.
8. Clean off the resist with its solvent.
9. Mat the background with matting tools if desired.
10. Buff to a high luster.
11. Lacquer or antique the surface as desired.





Suggested Etched Designs



Special stake for use in forming beveled rim

PROJECT 3.

PROJECT 4

Miniature Scuttle Ash Tray

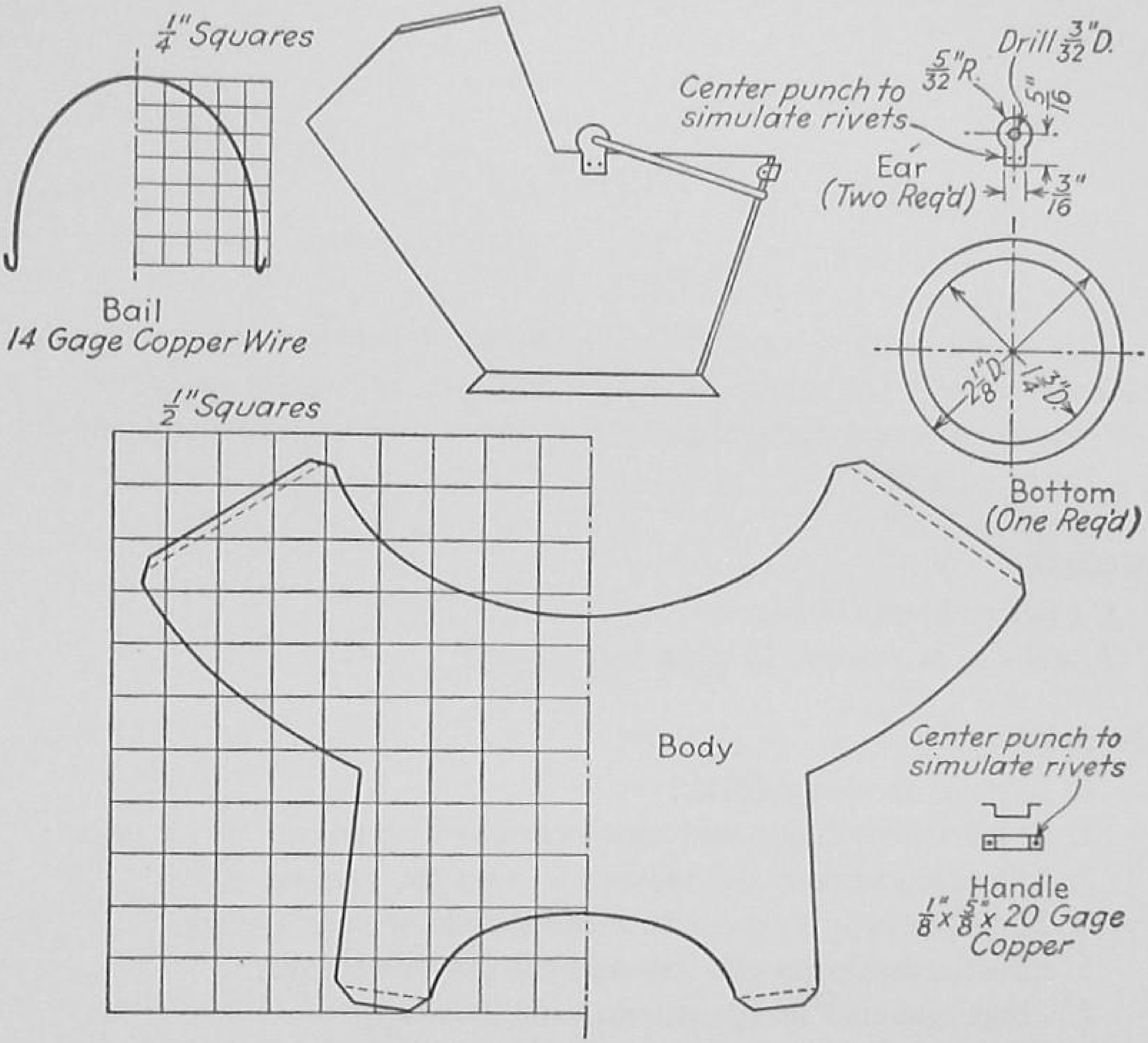
The miniature scuttle tray may be made and used for an ash tray or the pattern may be enlarged to a size 8″ or 10″ in height to be used for plants or ivy. A full-size pattern of the body should be made of stiff paper and folded into shape so that any inaccuracies in the layout may be corrected.

Material:

Copper or brass, 20 gage
Body: 5½″ x 9″
Bottom: 2½″ D disc
Base: Wire, #14 gage, 5½″ long
Ears and handle are made from scrap stock

Procedure:

1. Make a pattern of the body and trace it on the metal with a scriber.
2. Cut out the body blank with aircraft snips.
3. Clean the surfaces with steel wool.
4. Planish or peen the surface. (This step is optional.)
5. Fold the seams for a #6 hand groover.
6. Form the body over the end of a blow horn stake.
7. Hook seams together and groove the seams with a #6 hand groover.
8. File the edges true.
9. Solder the seams with a soldering copper.
   Note: Seams may be lapped and riveted instead of using the grooved seam.
10. Cut out the 2⅛″ D disc for the bottom and flange the edge as indicated in drawing by forming it over the end of a 1¾″ D rod of steel.
11. Lay out the ears, drill a 3/32″ hole in the ears for the bail.
12. Cut out the ears with a jeweler's saw.
13. Cut a ⅛″ strip of stock for the handle and form it as indicated in drawing.
14. Wire the bottom to the body and solder it with a Bunsen burner.
15. Sweat solder the ears and handle on the body.
16. Polish all surfaces.
17. Shape the wire for bail over a stake and bend the ends to fit in the ears.
18. Finish the surfaces by lacquering or antiquing as desired.


1/4" Squares
Bail
14 Gage Copper Wire
Drill 3/32" D.
5/32" R.
5/16"
Center punch to simulate rivets
Ear (Two Req'd)
3/16"
2 1/8" D.
1 3/4" D.
Bottom (One Req'd)
1/2" Squares
Body
Center punch to simulate rivets
Handle
1/8" x 5/8" x 20 Gage Copper

PROJECT 4.

PROJECT 5

Cigarette Tray

This tray is a miniature fireside log basket. It makes a good companion piece to go with the miniature scuttle ash tray previously described. By altering the size and shape slightly, the tray can be used for napkins, calling cards, or mail.

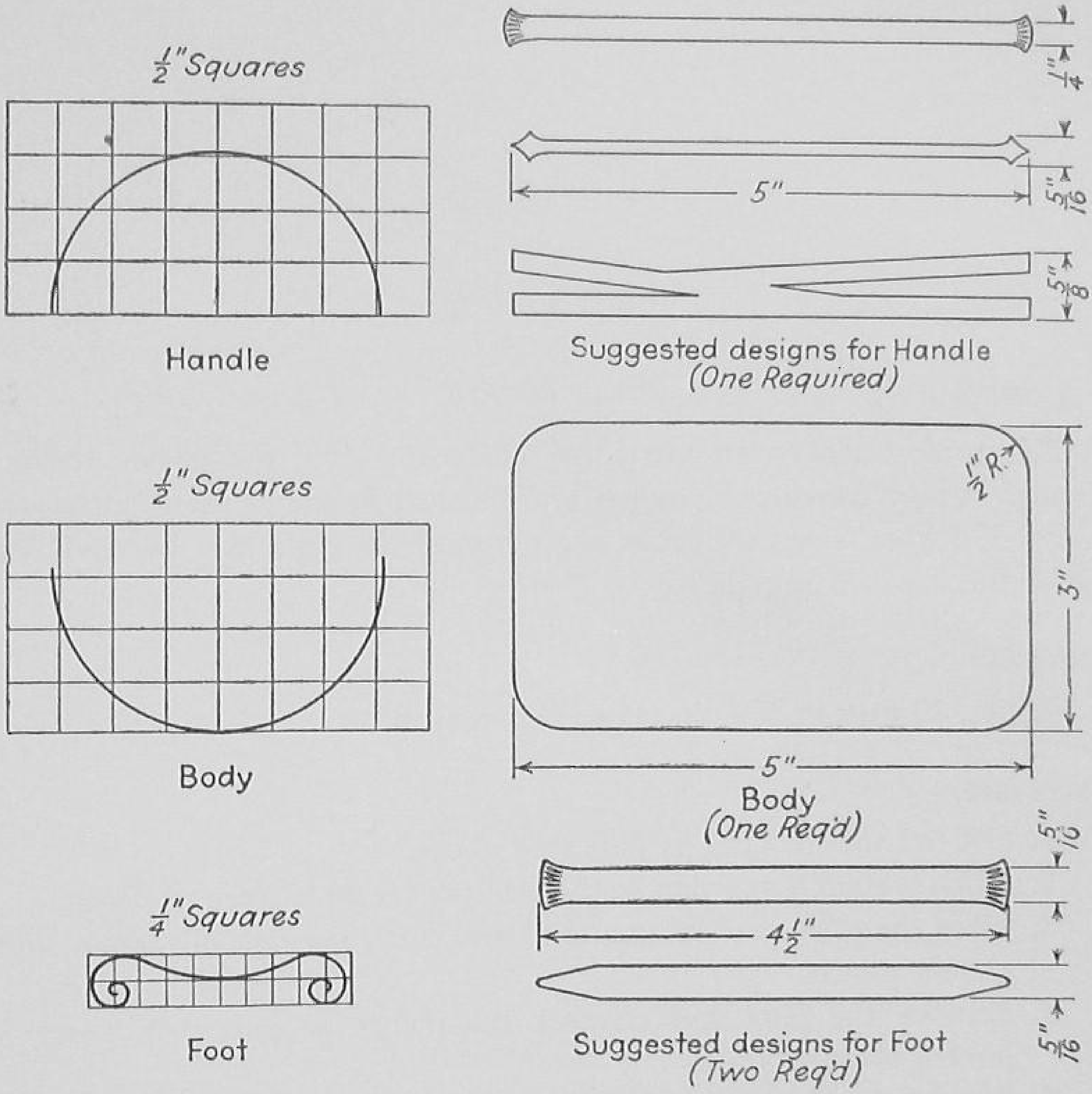
Material:

Copper or brass, 18 gage
Aluminum or pewter, 16 gage

Procedure:

1. Lay out the body blank.
2. Cut out body blank and round corners with snips.
3. File edges smooth and planish or peen the surface.
4. Form the body to shape in forming rolls or over a stake.
5. Select a design for the foot and cut out two blanks.
6. Shape the ends as suggested in the drawing.
7. Bend the ends to form a scroll using round-nose pliers.
8. Select a design for the handle and cut out a blank. Flat handles may be twisted or the handle may be made of twisted wire.
9. Bend handle to shape.
10. Tin the surfaces of the feet where they are to contact the body, clamp the feet in place on the body, and sweat-solder them in place.
11. Tin the handle at the ends, clamp it in place on the body, and solder the handle.

    Note: Handle and feet should be riveted in place instead of soldering if tray is made of aluminum.
12. Polish all surfaces.
13. Finish the surface by lacquering or antiquing as desired.



1/2" Squares
Handle
1/4"
5"
5/16"
5/8"
Suggested designs for Handle
(One Required)
1/2" Squares
1/2" R.
3"
5"
Body
Body
(One Req'd)
1/4" Squares
5/16"
4 1/2"
Foot
Suggested designs for Foot
(Two Req'd)
5/16"

PROJECT 5.

PROJECT 6

Wall Pocket

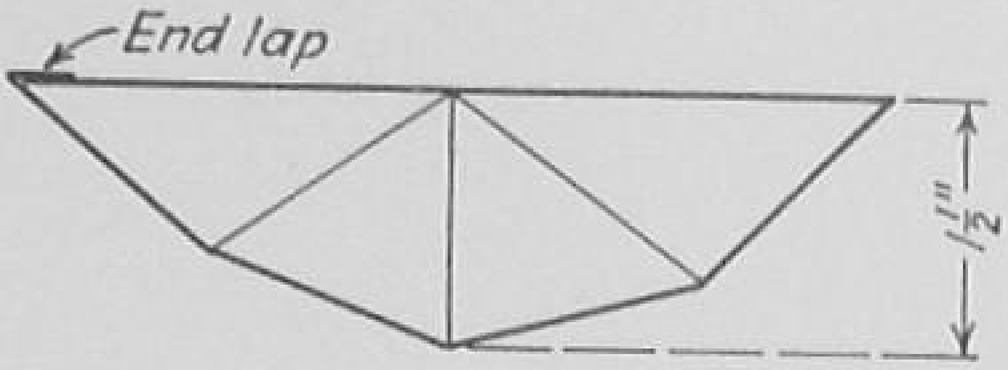
This project makes an attractive holder for ivy, flowers or trailing plants. It may be made of copper and finished in one of many attractive ways. If copper is not available, sheet iron or tin plate may be used, finishing the surfaces by painting.

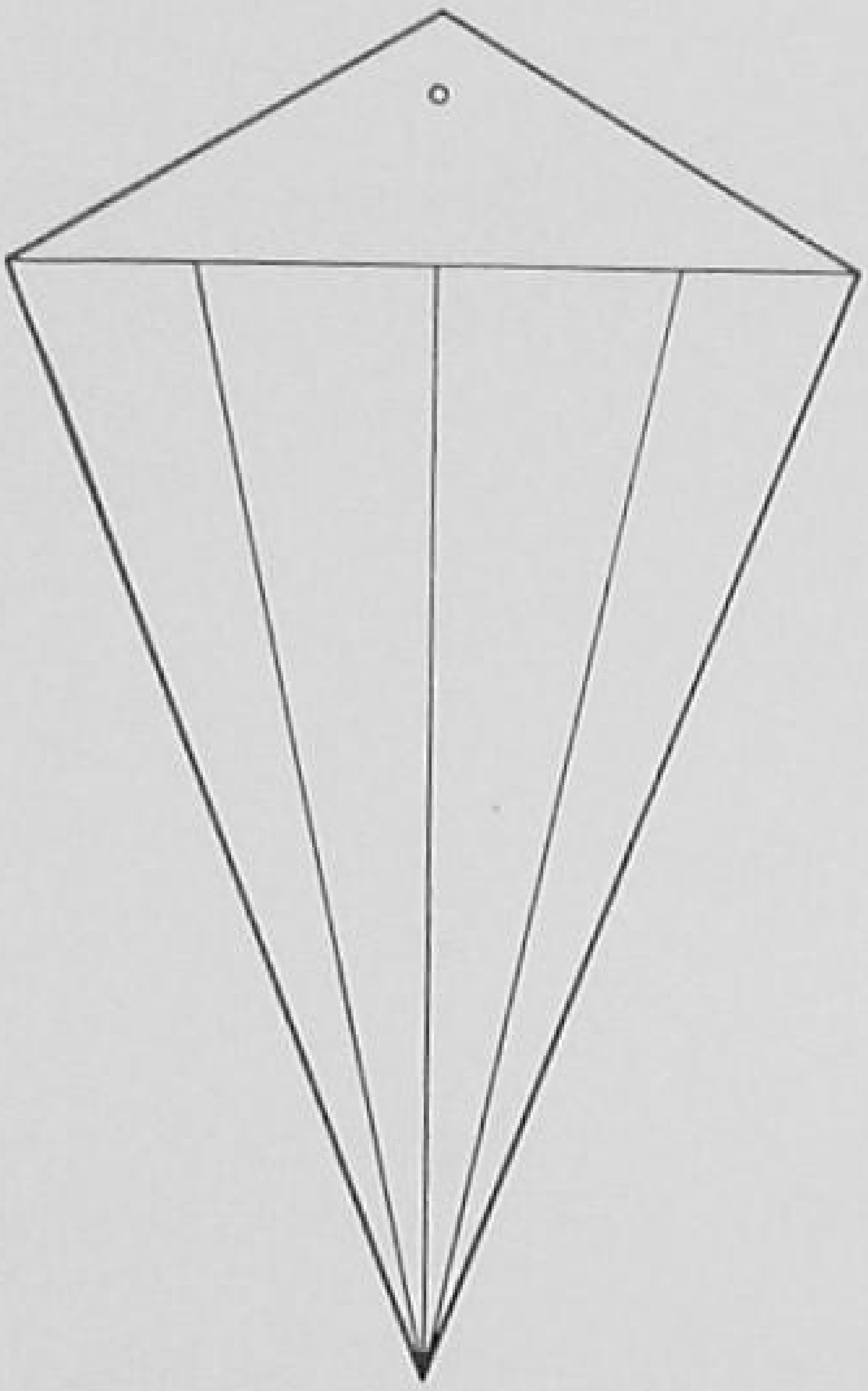
Material:

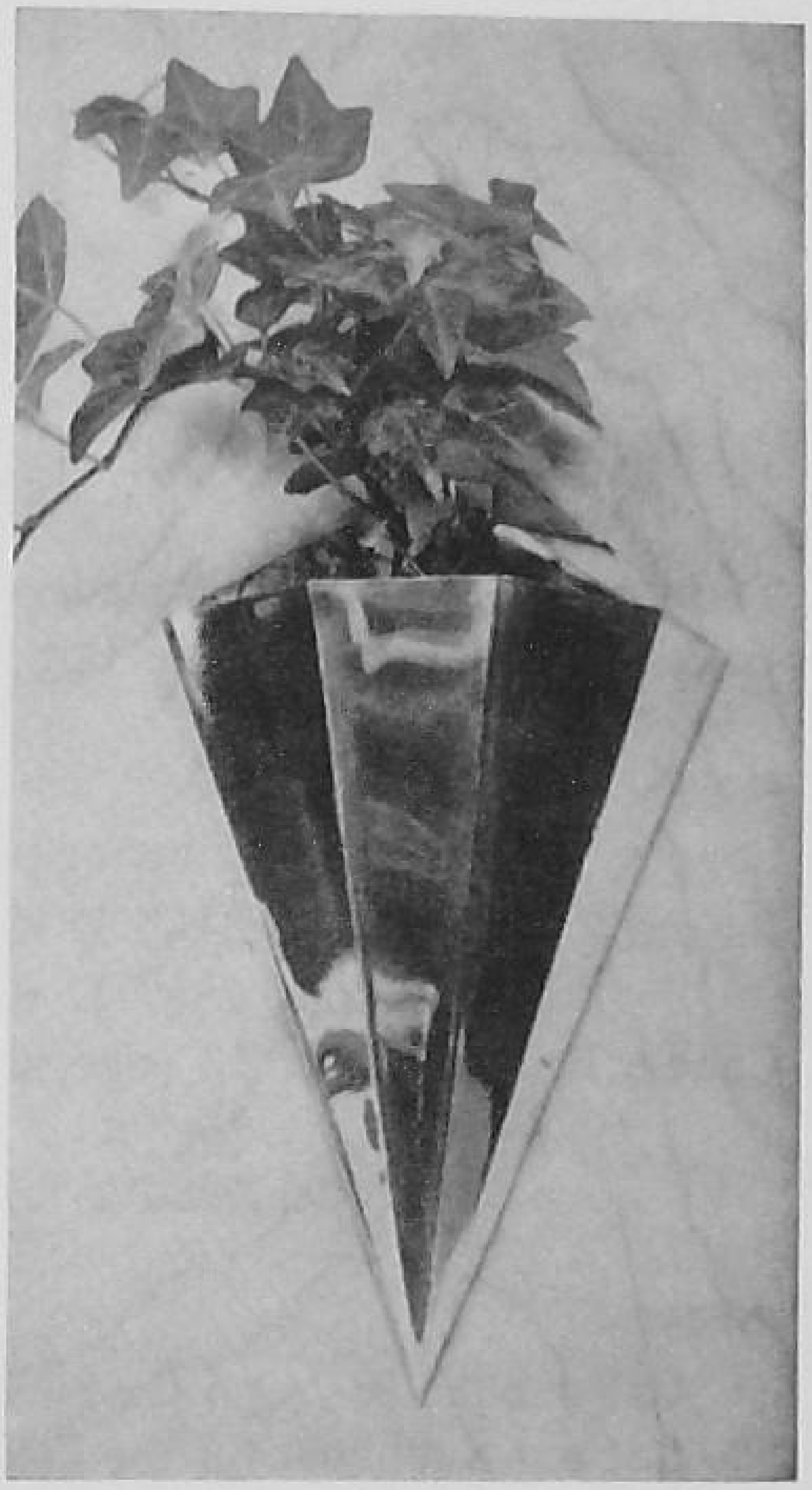
Copper, 20 gage *or* XX tin plate, 7¼″ x 10½″

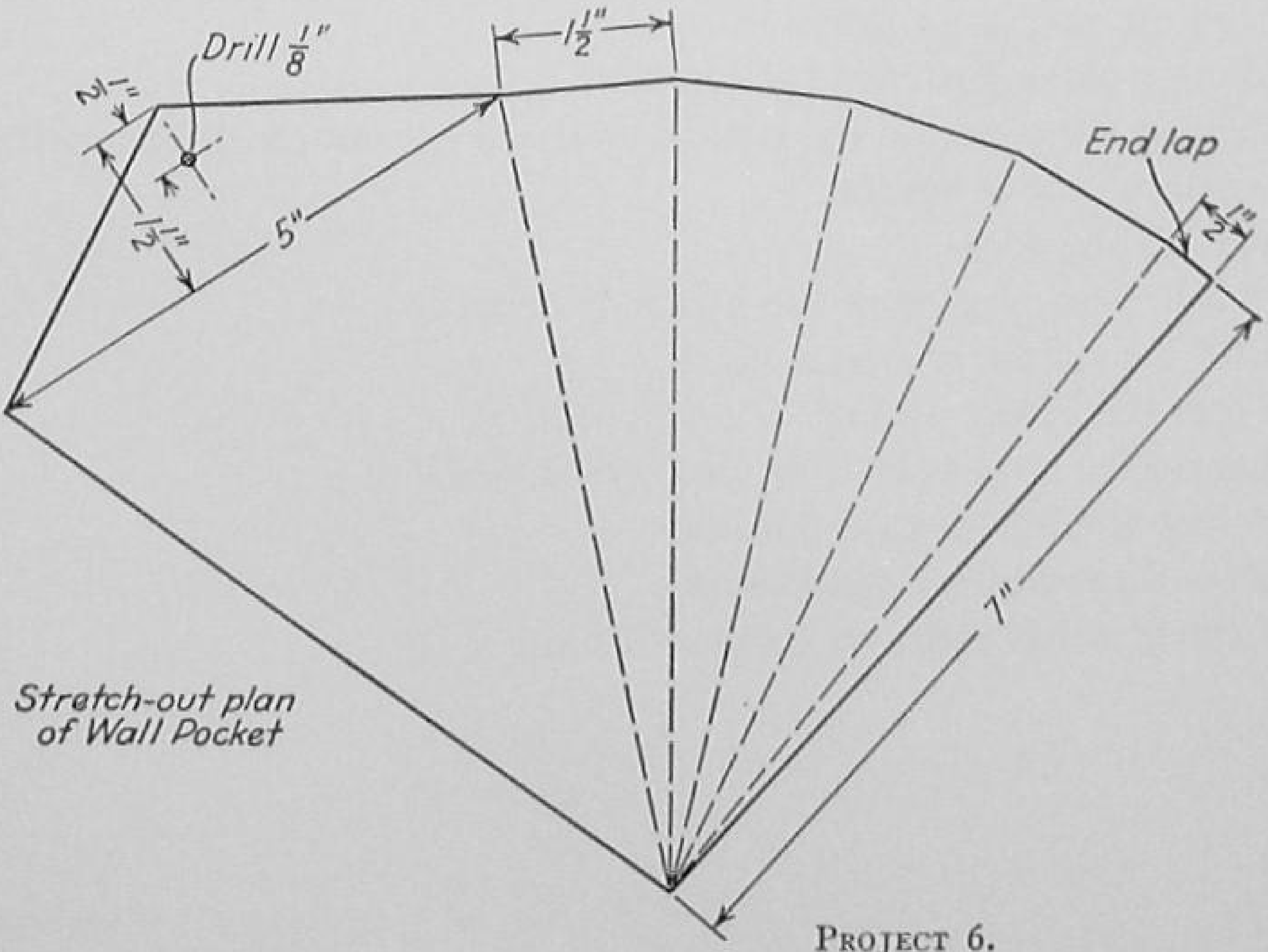
Procedure:

1. Cut out the material as indicated above.
2. Make a stretch-out plan of the wall pocket on a piece of paper.
3. Place the plan over the material and prick through all points with a prick punch.
4. Remove the plan and connect the points as indicated, using a scratch awl and scale.
5. Cut out the blank with tin snips.
6. Planish or peen if desired.
7. Starting with the end lap, bend folds as indicated by dotted line.
8. Fit the end lap over the back.
9. Solder the lap joint on the back.
10. Polish and lacquer or antique the surface.









Stretch-out plan of Wall Pocket

Project 6.

PROJECT 7

Candlesticks

These candlesticks may be made singly or in pairs. They may be made all of one material or of two or three contrasting metals.

Material:

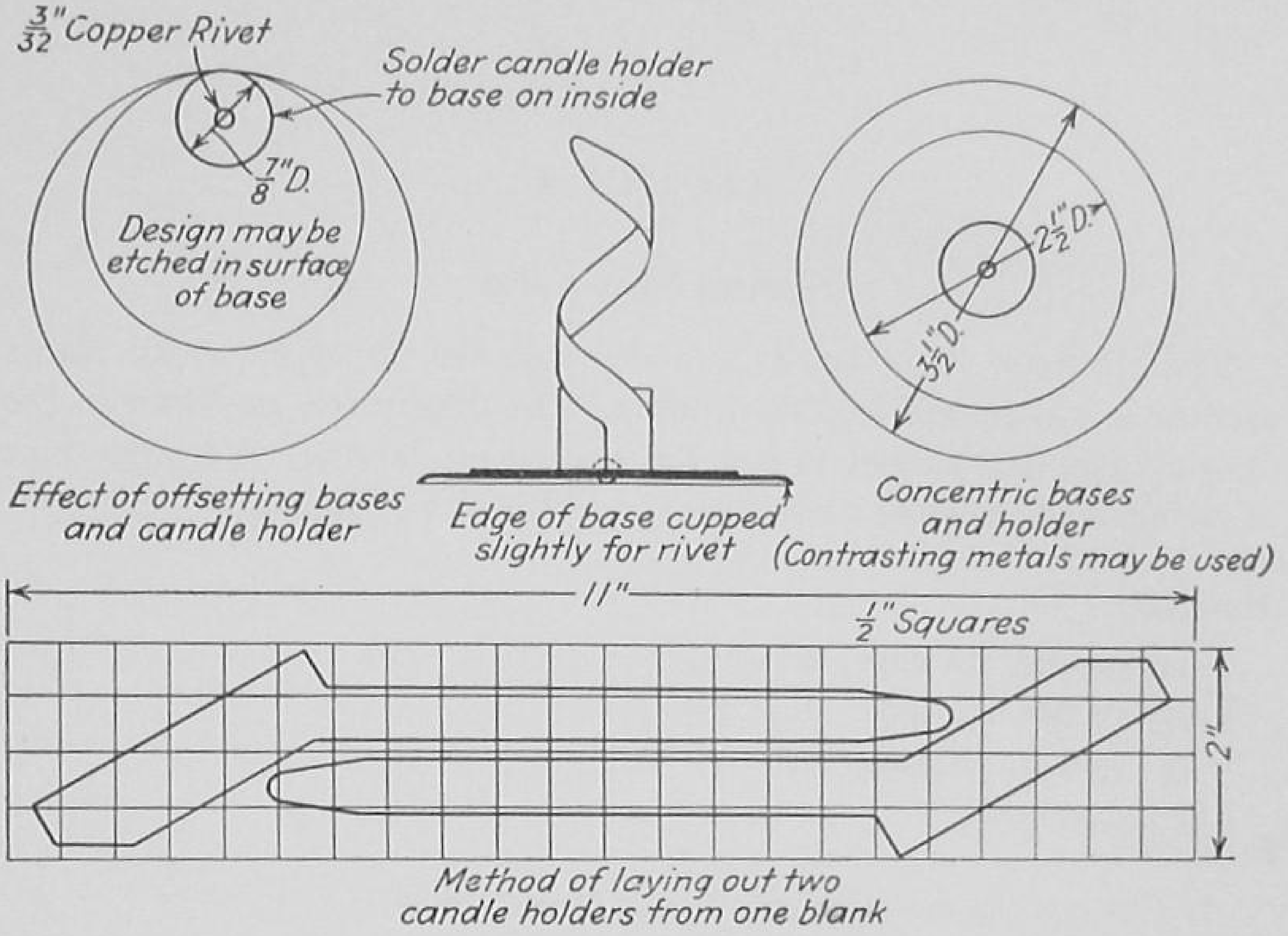
Copper, brass, German silver or pewter

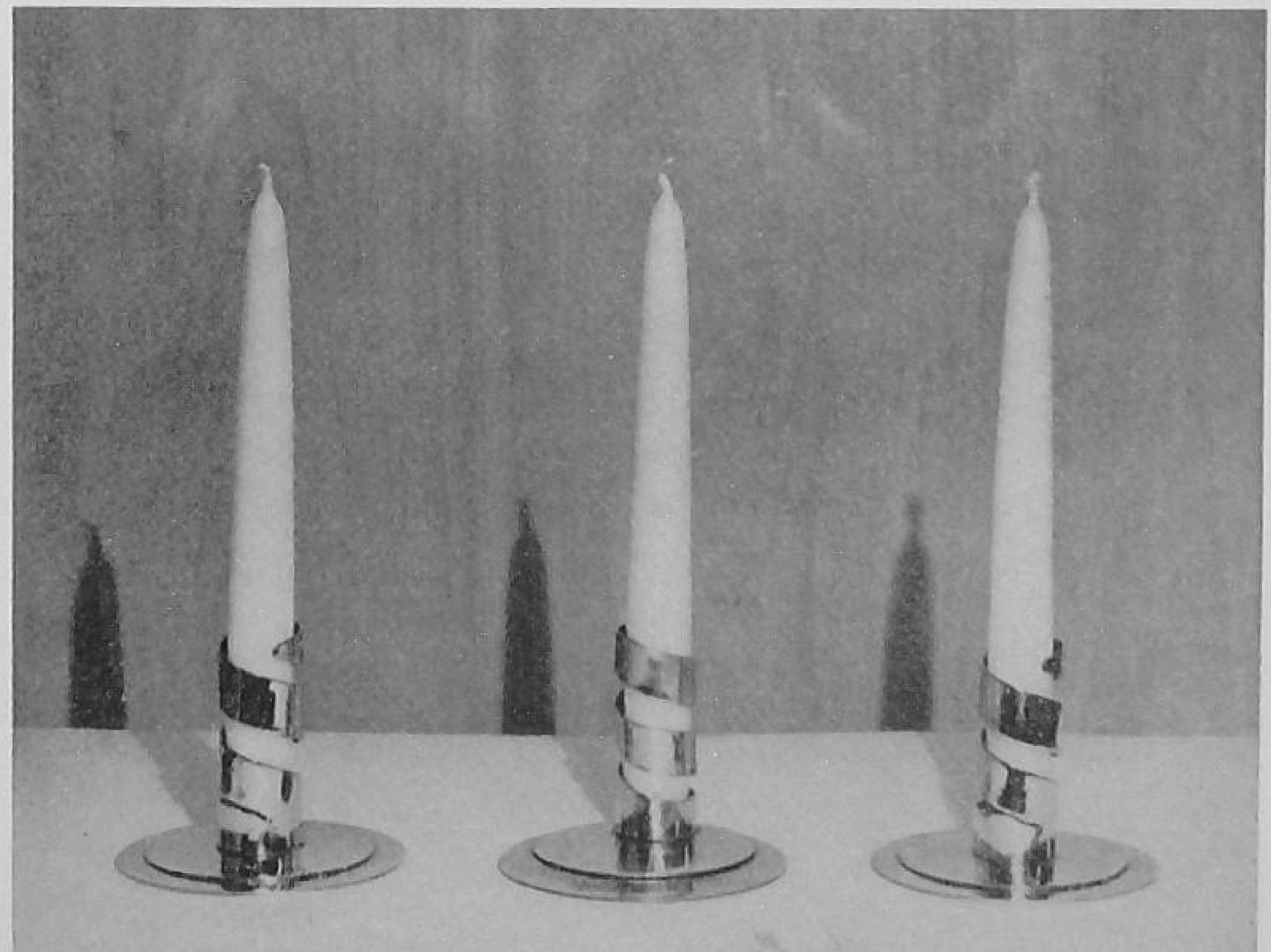
Bases: 2 pc. 16 gage, 3½″ D disc
2 pc. 16 gage, 2½″ D disc

Candle Holder: 1 pc. 18 gage, 2″ x 11″
2 ³⁄₃₂″ x ¼″ copper rivets
2 pc. felt 3½″ D

Procedure:

1. Cut out the bases on the circular shear.
2. Cut out the blank for the holders.
3. Prepare a suitable design for etching on the surface of the base.
4. Etch the design on the base.
5. Make a paper pattern of the holders.
6. Cement the paper on the metal blank and cut out the holders with a jeweler's saw or shears.
7. File all the edges.
8. Polish, peen or planish the holder if desired.
9. Buff the holder and base pieces.
10. Form the holder around a ⅞″ dowel rod.
11. Locate the rivet hole, drill, and rivet bases.
12. Solder the holder to the bases.
13. Rebuff candlestick and lacquer.
14. Cement a felt piece on bottom of base.


3/32" Copper Rivet
Solder candle holder to base on inside
7/8" D.
Design may be etched in surface of base
2 1/2" D.
3 1/2" D.
Effect of offsetting bases and candle holder
Edge of base cupped slightly for rivet
Concentric bases and holder (Contrasting metals may be used)
11"
1/2" Squares
2"
Method of laying out two candle holders from one blank



PROJECT 7.

PROJECT 8

Copper Plant Box

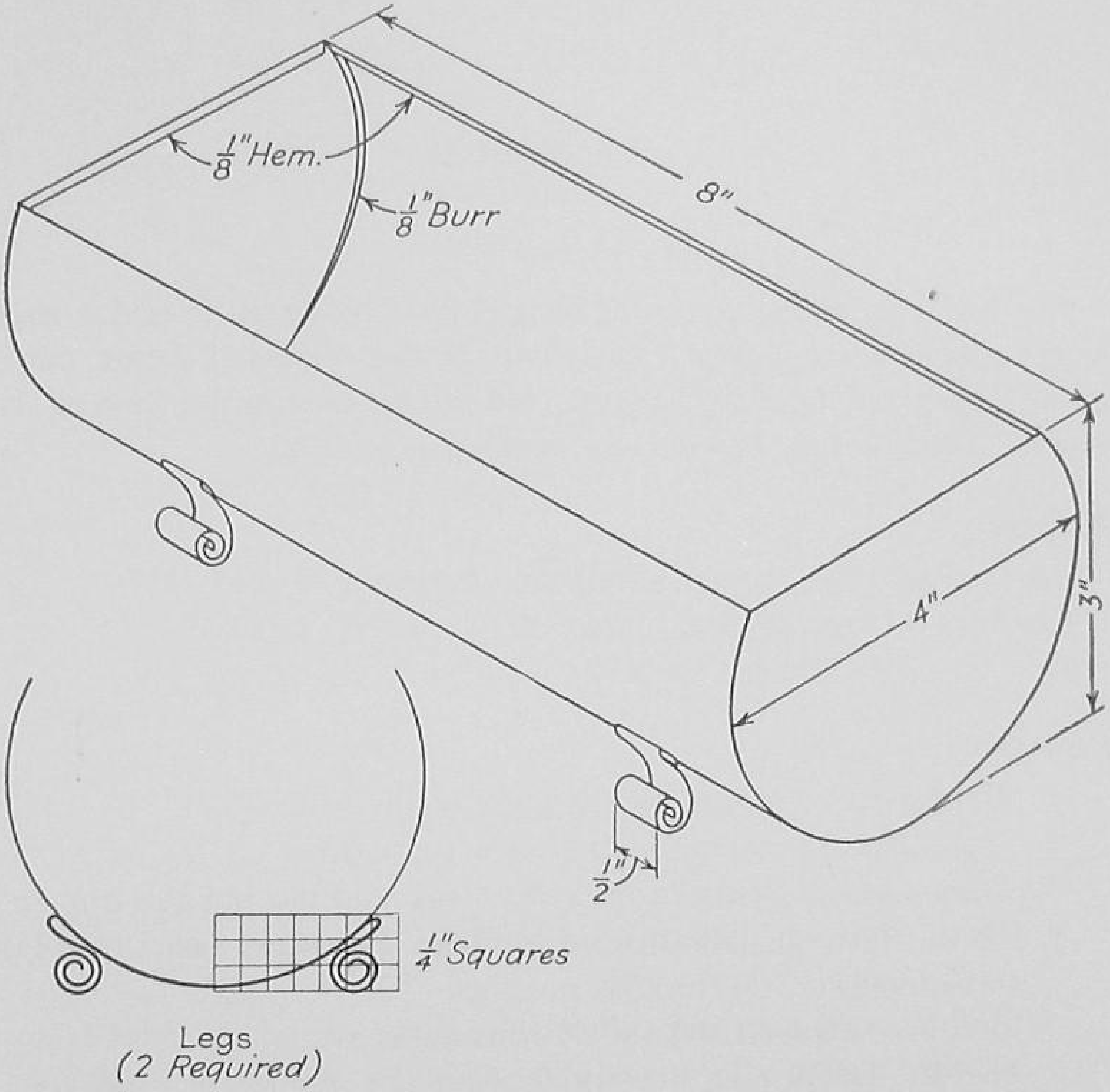
This attractive plant box is a useful item for displaying small plants such as a snake plant or philodendron. The dimensions as shown in the drawing may be changed to suit the craftsman; however it is important to maintain the original proportion if another size is desired.

Material:

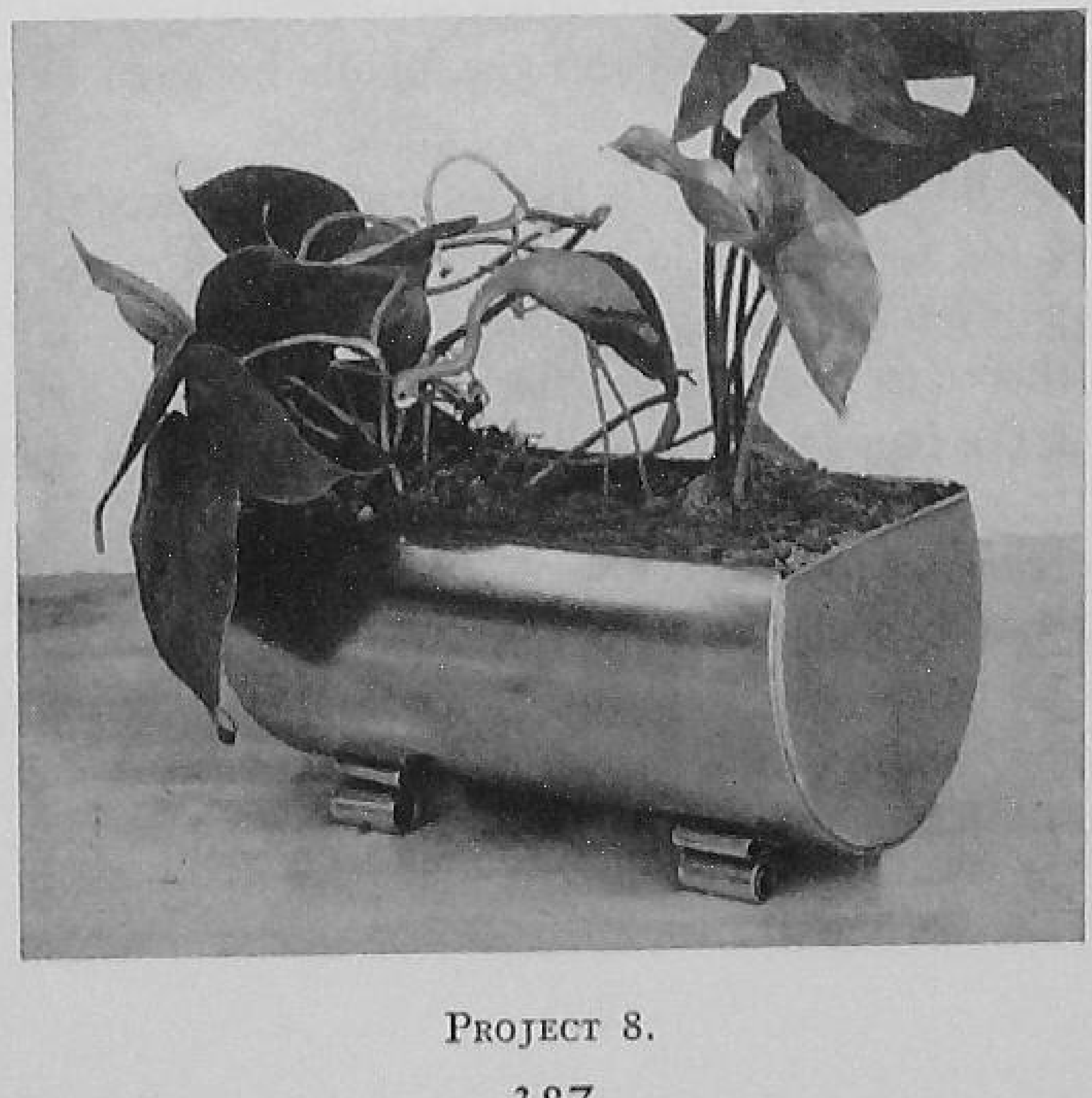
1 pc. copper, 22 gage, 8″ x 8¾″
2 pc. copper, 22 gage, 3¼″ x 4½″
2 pc. copper, 18 gage, ½″ x 8″

Procedure:

1. Cut out the material required as listed above.
2. Lay out a 4¼″ D segment of a circle on the blanks for the end pieces with dividers.
3. Cut out the segments with a pair of tin shears and turn a ⅛″ burr, as required, on the turning machine. The burr may be turned by hand over a round stake if no machine is available.
4. Fold the ⅛″ hem on the straight edge. (Corners should be notched to prevent the hem from interfering with the burr.)
5. Hem the edges of the 8″ x 8¾″ piece along the 8″ edge.
6. Form this part into a partial cylinder.
7. Assemble the pieces and bind them with binding wire.
8. Solder the seams on the inside using a soldering iron.
9. Form the ends of the legs as required using a pair of round nose plies and a stake.
10. Clean and polish all surfaces on the body and legs.
11. Tin the legs in preparation to sweat-soldering them to the body.
12. Wire the legs to the body with binding wire and sweat-solder them using a Bunsen burner.
13. Buff outside surfaces to a high luster.
14. Clean and lacquer all surfaces.



$\frac{1}{8}$" Hem.
$\frac{1}{8}$" Burr
8"
4"
3"
$\frac{1}{2}$"
$\frac{1}{4}$" Squares
Legs
(2 Required)



PROJECT 8.

PROJECT 9

Leaf Tray

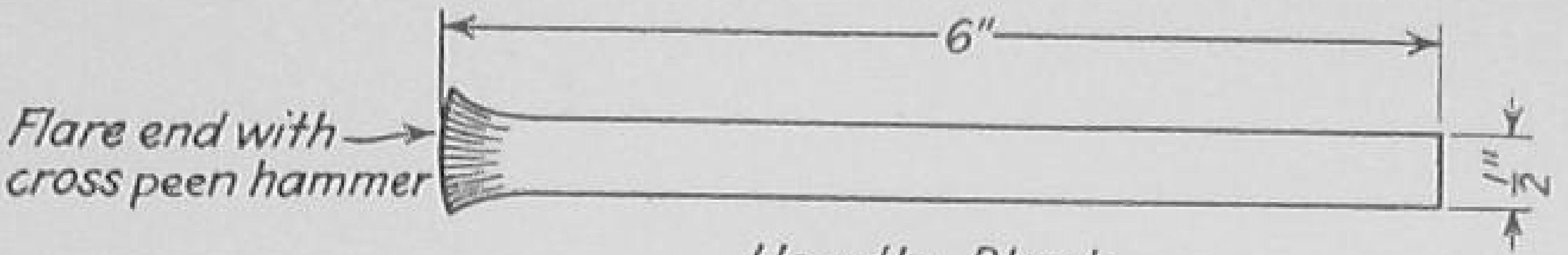
The leaf tray is an interesting project in forming an irregular shaped object over a wooden form. Variations of the suggested design may be made. When making such changes avoid the use of irregular lines or sharp curves. The tray may be used as a candy or nut dish.

Material:

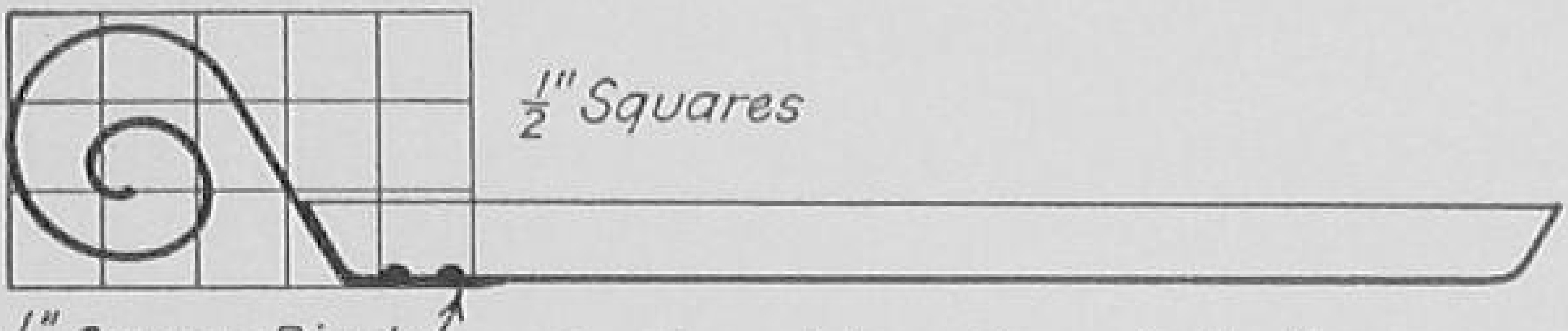
Body: 18 gage copper, aluminum or pewter, $5\frac{1}{2}'' \times 8\frac{1}{2}''$
Handle: 16 gage copper, aluminum or pewter, $\frac{1}{2}'' \times 6''$
2 rivets, $\frac{1}{16}'' \times \frac{1}{4}''$, round-head

Procedure:

1. Make a paper pattern of the body blank (solid line).
2. Make a paper pattern of the form (dotted line).
3. Trace the body pattern on body blank and cut out the copper.
4. Trace the form pattern on a block of 1″ maple, and cut out two mold blanks.
5. With a wood rasp and cabinet file, shape one of the form blank as shown. Round all corners and sandpaper the blank smooth.
6. Peen or planish the copper blank if desired.
7. Anneal the blank and clamp the blank between the two wooden forms with "C" clamps.
8. Work the flange down onto the form, using a wedge-shaped mallet.
9. Remove the forms, pickle and clean the blank.
10. True up the edges, using a surface gage.
11. Chase the veins in leaf from the reverse side.
12. Cut out the handle blank and peen or planish the surface.
13. Flare the end of handle as suggested in drawing.
14. Form the scroll for the handle and fit it to the body.
15. Locate and drill holes for the rivets through both pieces.
16. Buff each piece separately before assembling.
17. Rivet the handle to the body.
18. Lacquer all the surfaces or antique as desired.

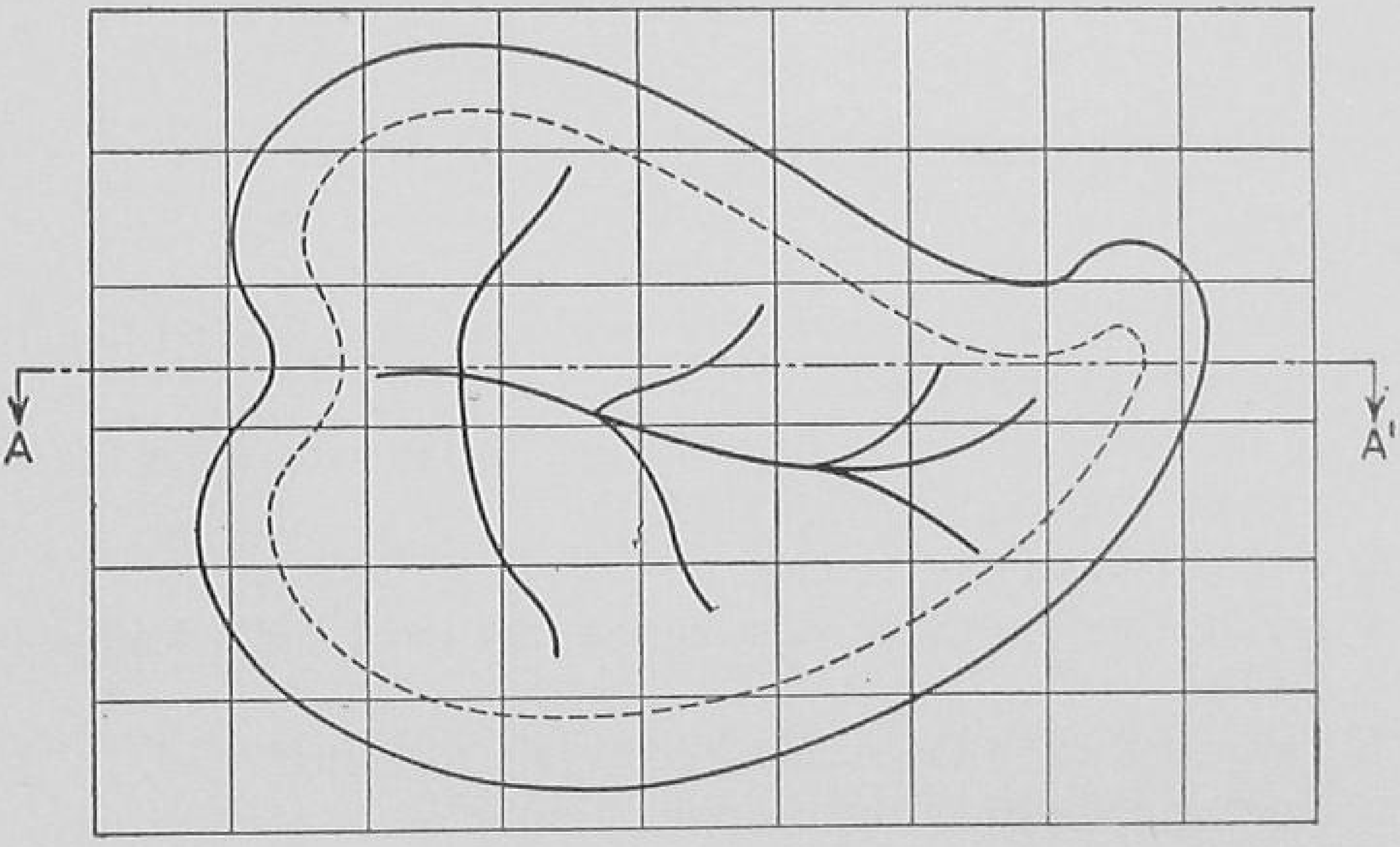


Handle Blank

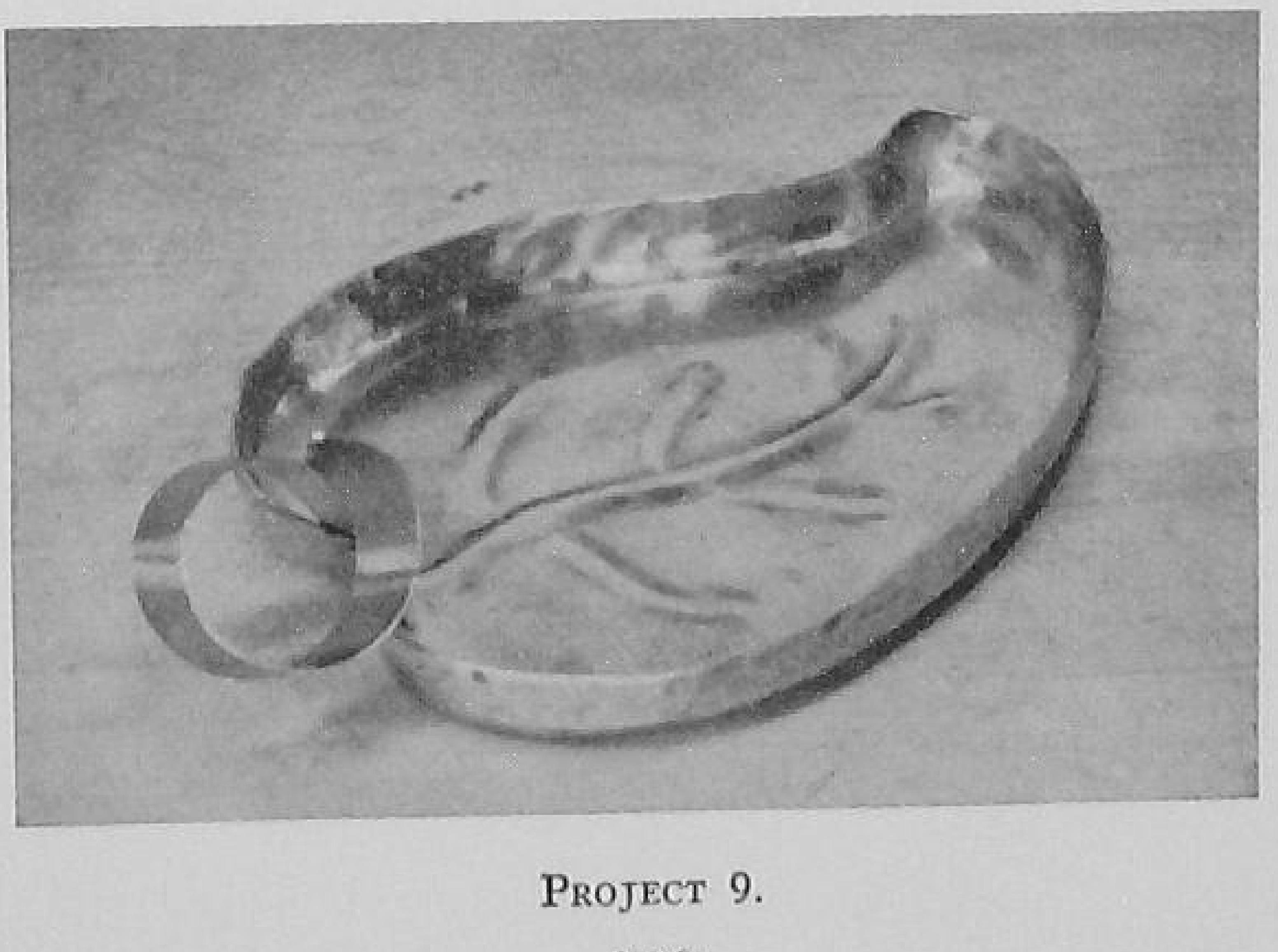


Section of tray through A-A'

1" Squares



Body Blank



PROJECT 9.

PROJECT 10

Ash Tray

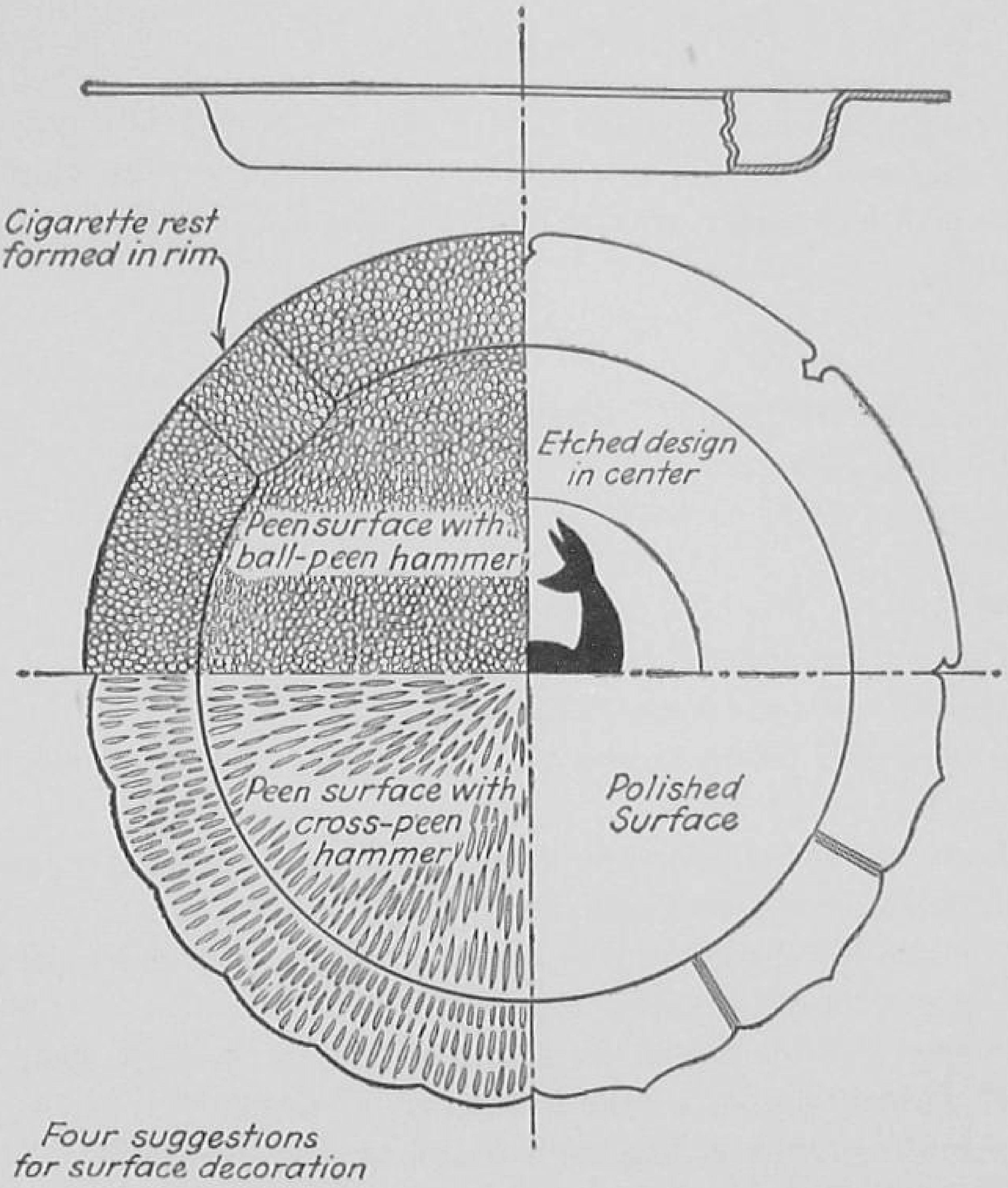
This tray may be used as a pin tray or ash tray. Many variations of surface and edge designs make it an interesting project. The size of the tray depends upon the forms which are available. If no tray form is available, one may be made on the wood-turning lathe to conform to one's own design. For instruction on wood turning, see *Woodworking Crafts* by Raymond Van Tassel.

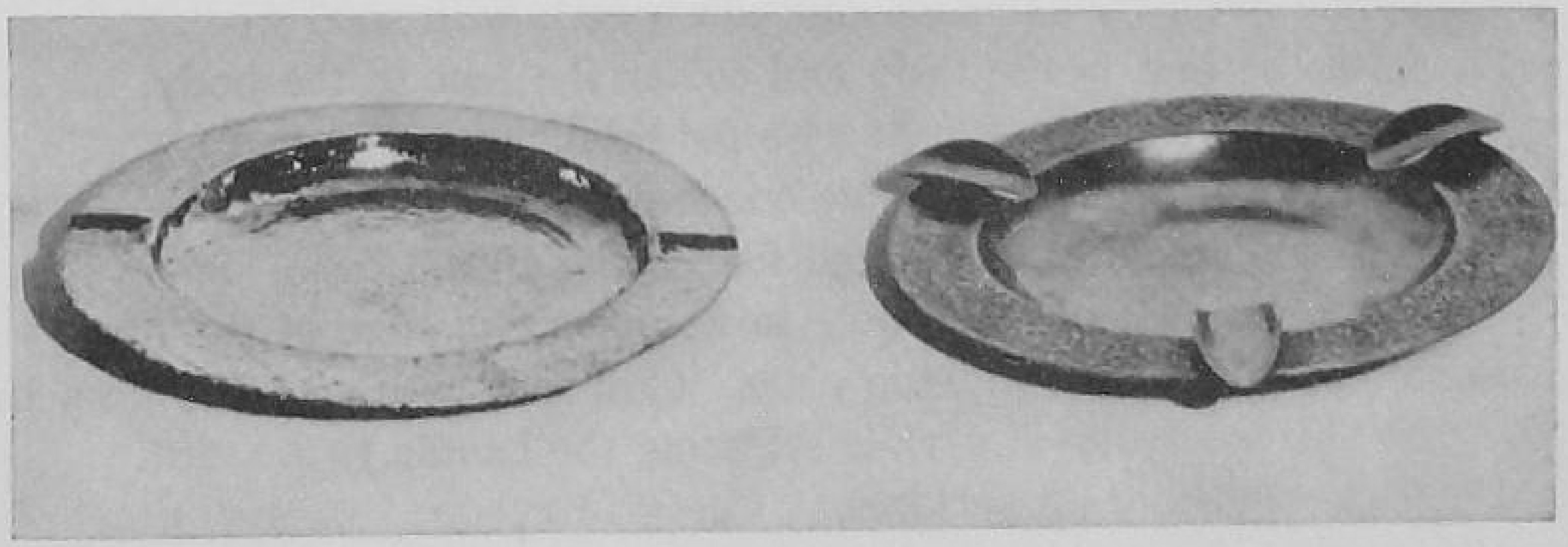
Material:

18 gage copper, brass, or pewter

Procedure:

1. Measure the recess in the tray mold and cut a disc on the circular shears to fit the recess.
2. If the surface is to be peened, peen the surface using the proper hammer and a planishing block.
3. Anneal and flatten the disc.
4. Sink the well in the tray, using the tray mold and a leather-tipped mallet.
5. Pickle and clean the surface thoroughly with steel wool.
6. True up the edge of the rim with a mill file.
7. If an edge design is to be used, make a number of equal divisions on the rim and lay out the contour of the design, using a stiff paper template.
8. Saw the edge design with a jeweler's saw and file edges.
9. Cigarette rests may be sunk in the rim using a hammer and wooden block or holders may be formed and soldered to the rim.
10. Certain edge designs are improved by fluting the rim by holding the rim on a block of wood and marking the flute with a dulled cold-chisel.
11. An etched design may be used in the center of a tray not peened.
12. Polish all surfaces.
13. Lacquer or antique as required.


Cigarette rest formed in rim
Etched design in center
Peen surface with ball-peen hammer
Peen surface with cross-peen hammer
Polished Surface
Four suggestions for surface decoration



PROJECT 10.

PROJECT 11

Candy Dish

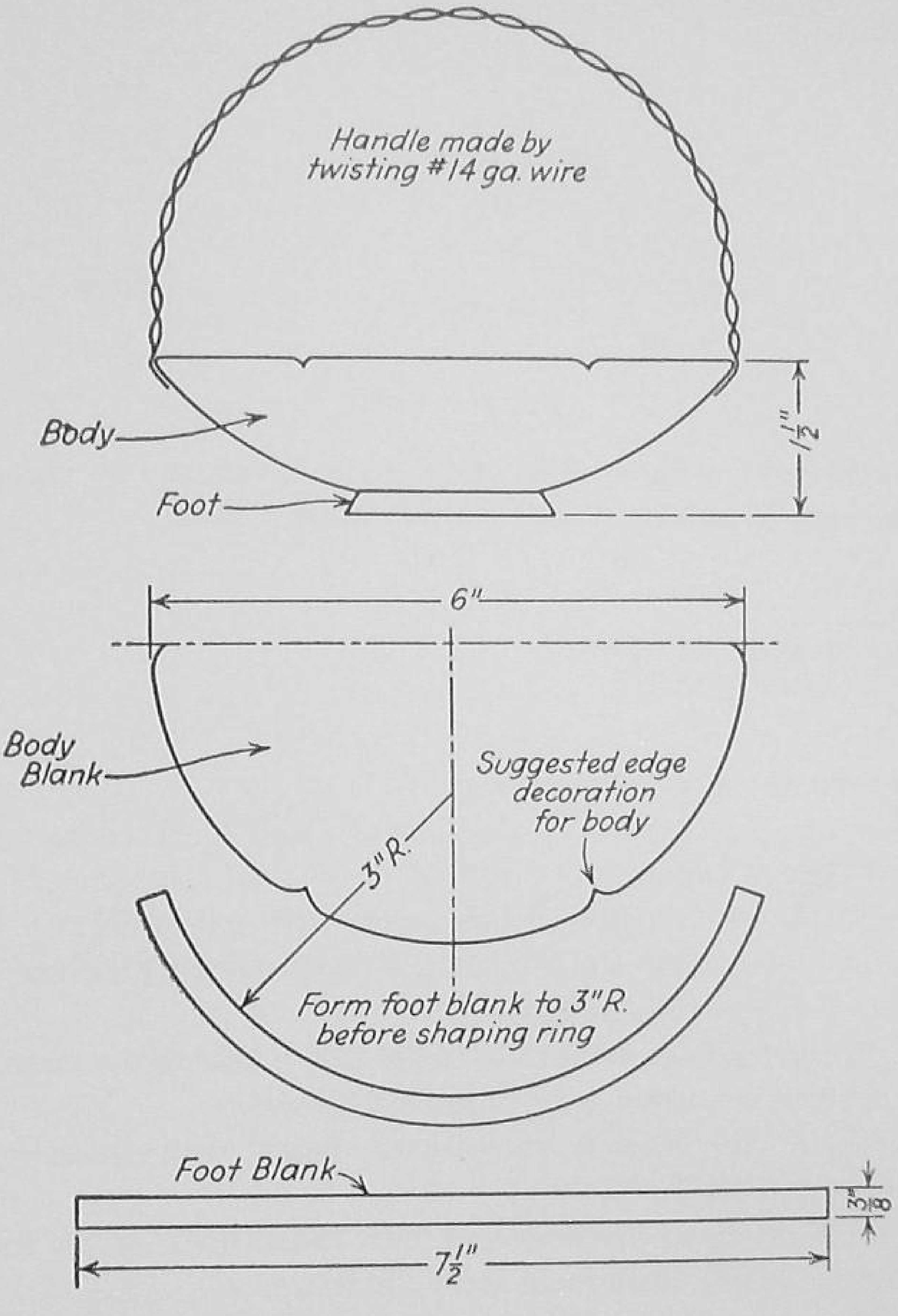
This candy dish is so shallow that it can be formed with only one annealing. Since the tray is so shallow, the usual procedure of planishing after the dish is formed is reversed and the blank is planished before forming the dish.

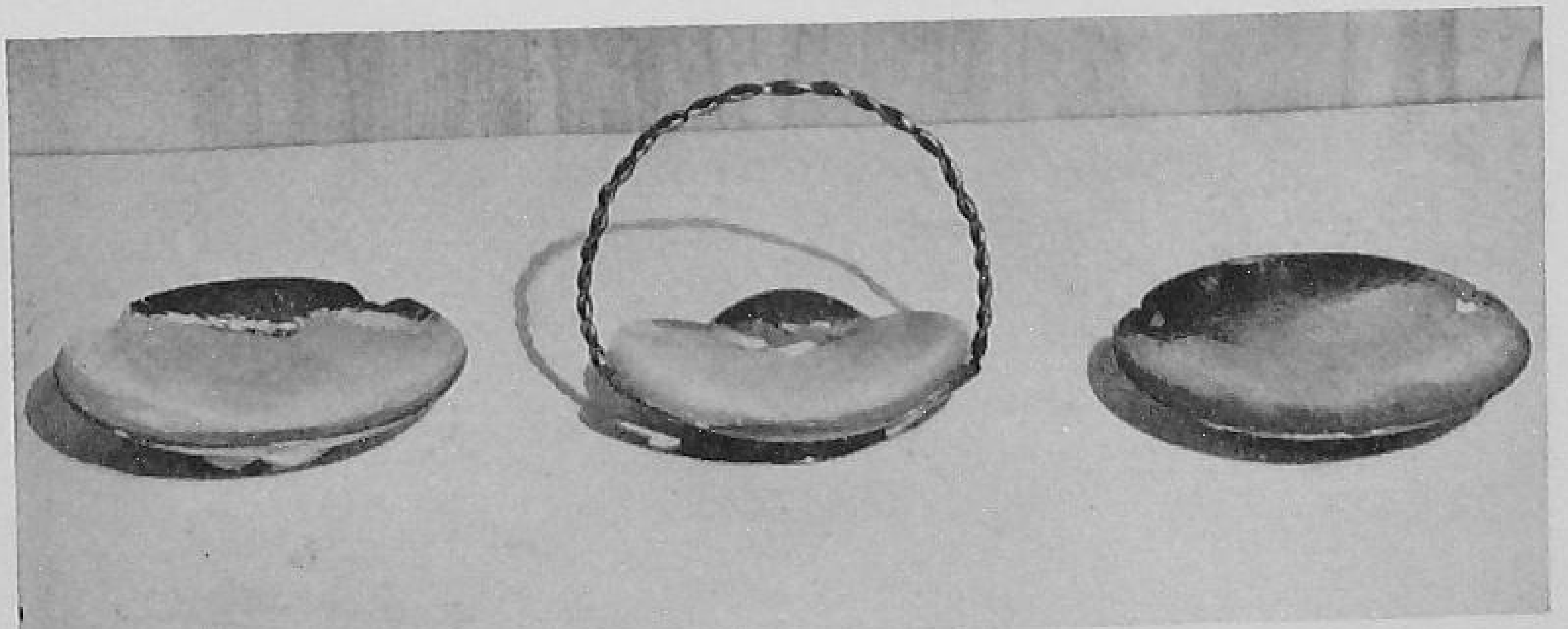
Material:

1 pc. copper, 18 gage, 6″ diameter
1 pc. copper, 16 gage, 3/8″ x 7½″
2 pc. copper wire, 14 gage, 12″ long

Procedure:

1. Cut out the material for the body.
2. Planish the surface carefully on a planishing block.
3. Anneal and pickle the blank and flatten it between two blocks of wood.
4. Mark out the divisions on the circumference of the disc, and with a template, mark out design for the edge decoration.
5. Cut out the design for the edge decoration with a jeweler's saw.
6. Cut out the material for the foot.
7. Anneal this blank and form to a 3″ radius as illustrated. Use the 6″ D body disc as a gage to test the 3″ radius.
8. Form the foot in a ring and cut and file the ends to fit.
9. Place the body blank into a spherical tray-mold and sink the blank into the mold. (A satisfactory mold can be made on the wood-turning lathe from hard wood.)
10. Pickle the body and foot and polish each with steel wool.
11. Wire the foot to the body and solder the foot to the body.
12. Clean two lengths of #14 wire for the handle.
13. Twist these wires by holding one end in the vise.
14. Cut the handle to length and flatten the ends.
15. Bend the ends of the handle to fit under the edge of the tray.
16. Sweat-solder the handle in place. (Fill foot with water to keep the foot from unsoldering while soldering the handle.)
17. Clean and buff all surfaces.
18. Lacquer the surface.


Handle made by twisting #14 ga. wire
Body
Foot
1 1/2"
6"
Body Blank
Suggested edge decoration for body
3" R.
Form foot blank to 3" R. before shaping ring
Foot Blank
3/8"
7 1/2"



PROJECT 11.

PROJECT 12

Fluted Bowl

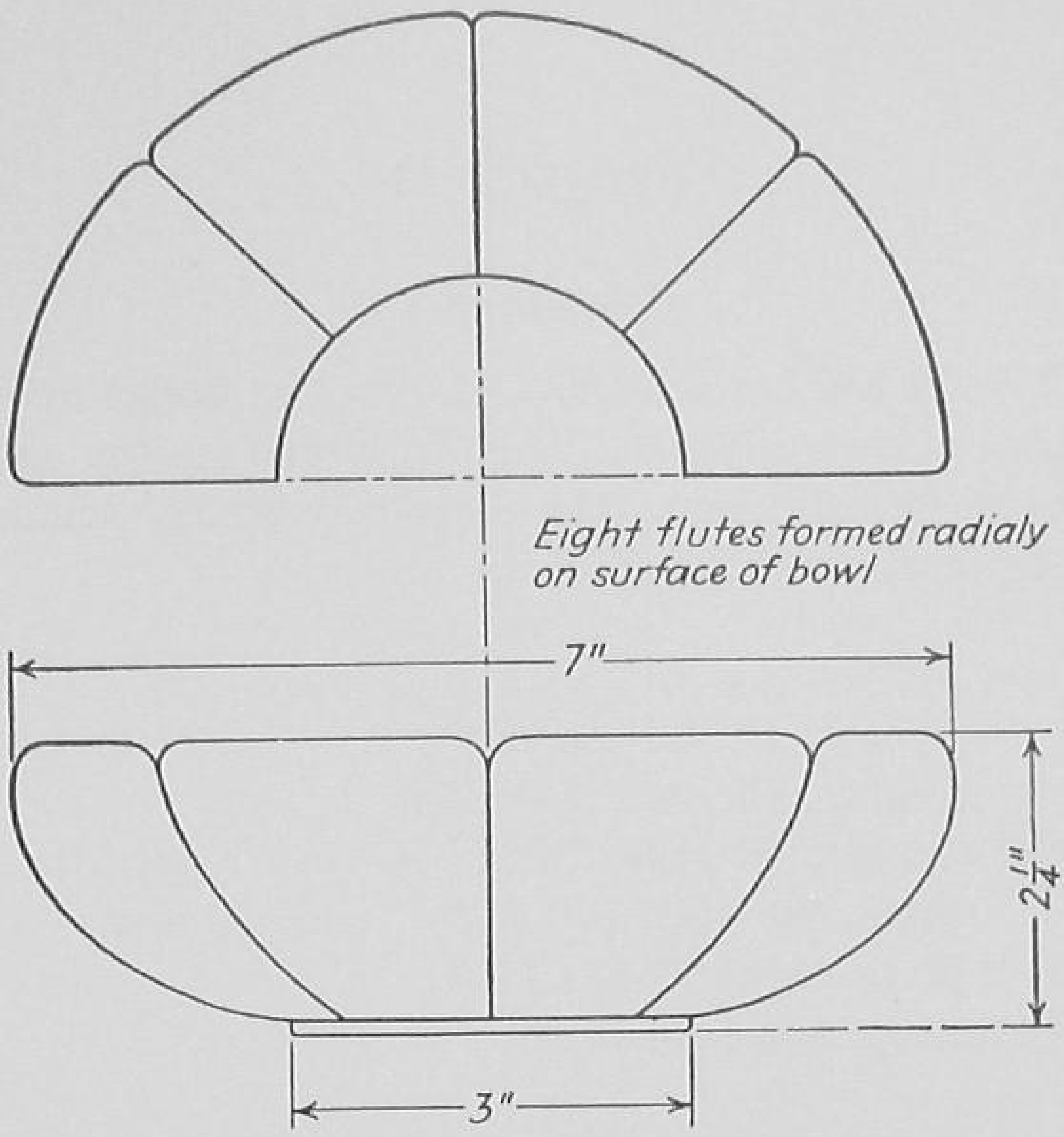
The fluted bowl is an excellent example of what may be accomplished with a flat disc by raising it on a lead or wooden block.

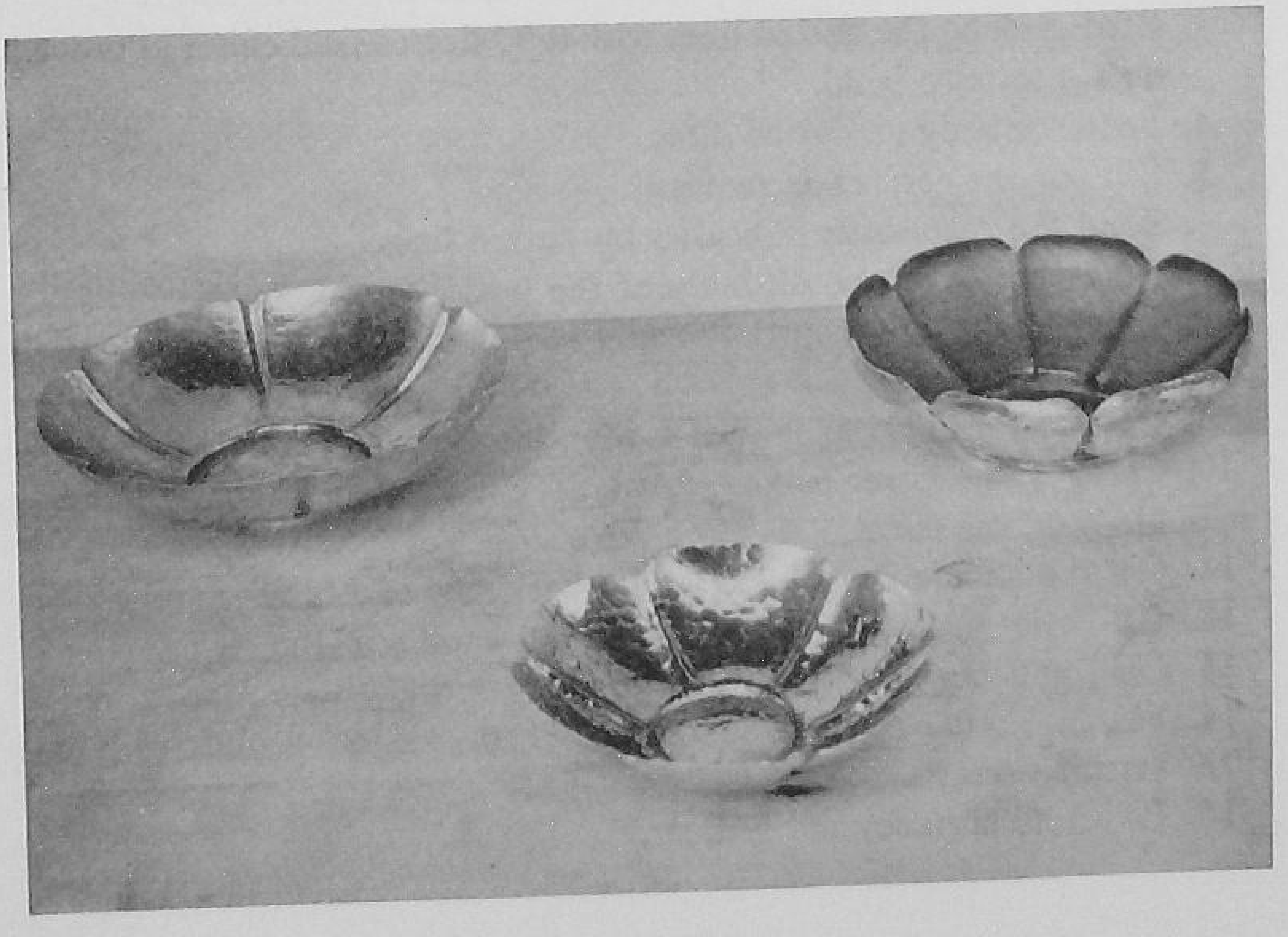
Material:

Copper, 18 gage, 9″ diameter

Procedure:

1. Cut out the disc and anneal it.
2. Raise the disc using a raising hammer and block of hard wood or lead. (See Chapter 3.)
3. Pickle the bowl and clean thoroughly with steel wool.
4. Select a planishing stake to fit the bowl and a planishing hammer.
5. Planish the outside surface.
6. Form the flat bottom with a mallet and a bottoming stake.
7. Shoulder the bottom with a necking hammer.
8. "True-up" the edge by marking the height with surface gage and trim excess stock.
9. Make eight equal divisions and draw radial lines for the flutes.
10. Prepare fluting blocks and form the flutes.
11. Scallop the edge as desired.
12. Buff all surfaces.
13. Lacquer or antique and wax the surface.





PROJECT 12.

PROJECT 13

Button Box

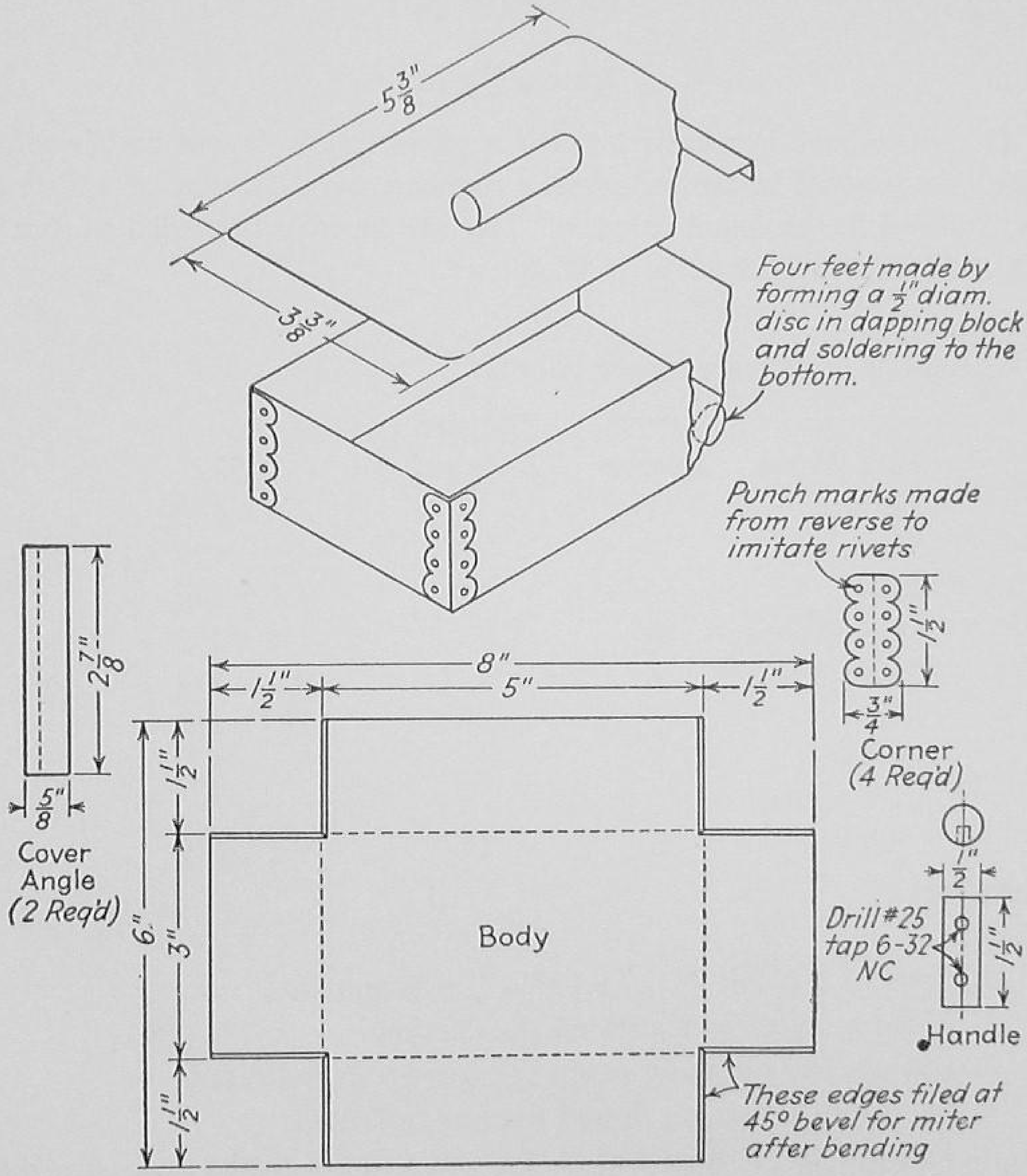
This small metal box has a number of uses. Its design may be altered to suit the taste of the craftsman. The surfaces of the top and sides lend themselves to an etched design. The cover may be left without a handle and an over-lay design may be applied.

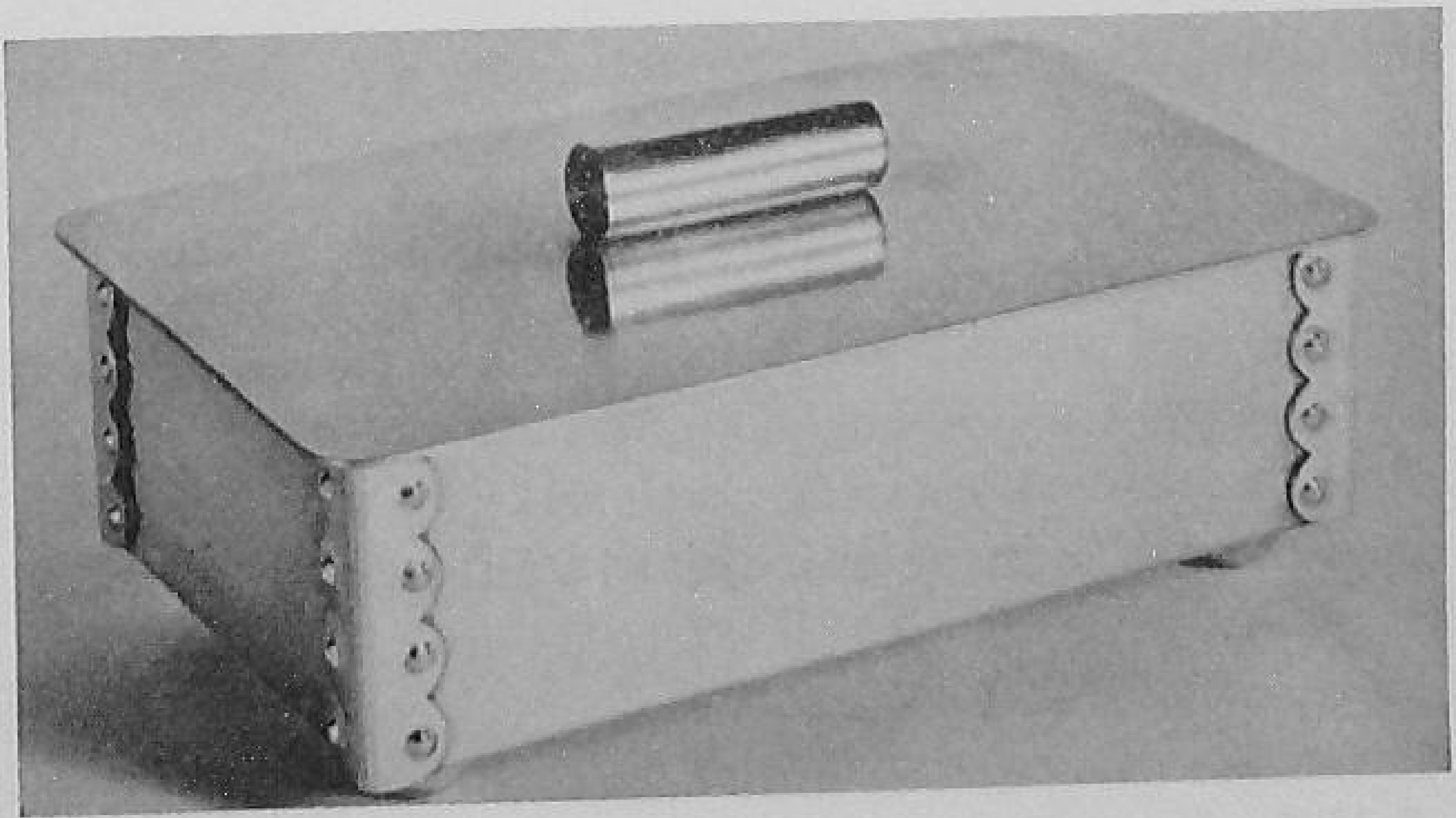
Material:

Body:	Copper, 18 gage, 6″ x 8″
Cover:	Copper, 16 gage, 3⅜ x 5⅜
Cover angle:	Copper, 18 gage, ⅝″ x 2⅞ (two required)
Corner:	Brass, 20 gage, ¾″ x 1½ (four required)
Handle:	Brass rod, ½″ D x 1½″
Feet:	Scrap copper or brass

Procedure:

1. Cut out stock for the body as required.
2. File the edges as indicated at a 45-degree angle for mitering.
3. Groove along the dotted lines with a 90-degree cold chisel in order to obtain a sharp bend.
4. Bend the body on dotted lines.
5. Cut out the corners as required.
6. Bend the corners as indicated by dotted lines.
7. Solder corner pieces on body of the box.
8. Form four dome-shaped feet and solder them to the bottom of the box.
9. Cut out the cover as required, round the corners, and file the edges.
10. Cut out the cover angles, bend as indicated, and solder them in place on the cover.
11. Cut the handle from a rod with a hack saw and file the ends.
12. Drill two $\frac{3}{16}$″ diameter holes for the handle in the cover.
13. Drill and tap holes in handle as indicated.
14. Fasten handle to cover with two #10-24 x ¼″ round-head brass machine screws.
15. Polish all surfaces and lacquer.


5 3/8"
3 3/8"
Four feet made by forming a 1/2" diam. disc in dapping block and soldering to the bottom.
Punch marks made from reverse to imitate rivets
1 1/2"
3/4"
Corner (4 Req'd)
2 7/8"
5/8"
Cover Angle (2 Req'd)
8"
1 1/2"
5"
1 1/2"
6"
1 1/2"
3"
1 1/2"
Body
1/2"
Drill #25 tap 6-32 NC
1 1/2"
Handle
These edges filed at 45° bevel for miter after bending



PROJECT 13.

PROJECT 14

House Bank

The house bank is a project which requires care in layout and bending. Coins are inserted in the rectangular chimney and bills may be rolled up and inserted in the round chimney. The bottom may be folded so that it will slide when it is required to be opened.

Material:

1C tinplate or 22 gage copper or brass

Part Name	*Part Number*	*Number Required*	*Size*
Bottom	1	1	3 1/16 x 4 3/8
Sides	2	1	4 3/16 x 11 3/16
Roof	3	1	4 1/4 x 4 3/4
Oval chimney	4	1	1 1/4 x 2 1/4
Oval chimney	4	1	3/16 x 4 1/2
Dormer	5	2	1 1/2 x 2 3/4
Dormer	5	2	5/16 x 2
Rectangular chimney	6	1	1 1/4 x 2 7/8

Procedure:

Sides

1. Prepare a blank 4 3/16″ x 11 3/16″ as required.
2. Make a layout as shown on the drawing.
3. Cut out the sides and notch the corners as indicated.
4. Bend the corners on dotted lines as indicated.
5. Fold for the bottom and roof seams using a mallet on a straight-edged stake.
6. Solder the corner seam on the inside with a soldering copper.

Roof

1. Prepare a blank 4 1/4 x 4 3/4.
2. Notch corners as indicated.
3. Lay out and punch hole the 3/4″ D in roof with a hollow punch.
4. Lay out and cut the slot for rectangular chimney.
5. Hem the edges on bar folder or on stake.
6. Fold the roof on ridge as indicated by the dotted line.

Bottom

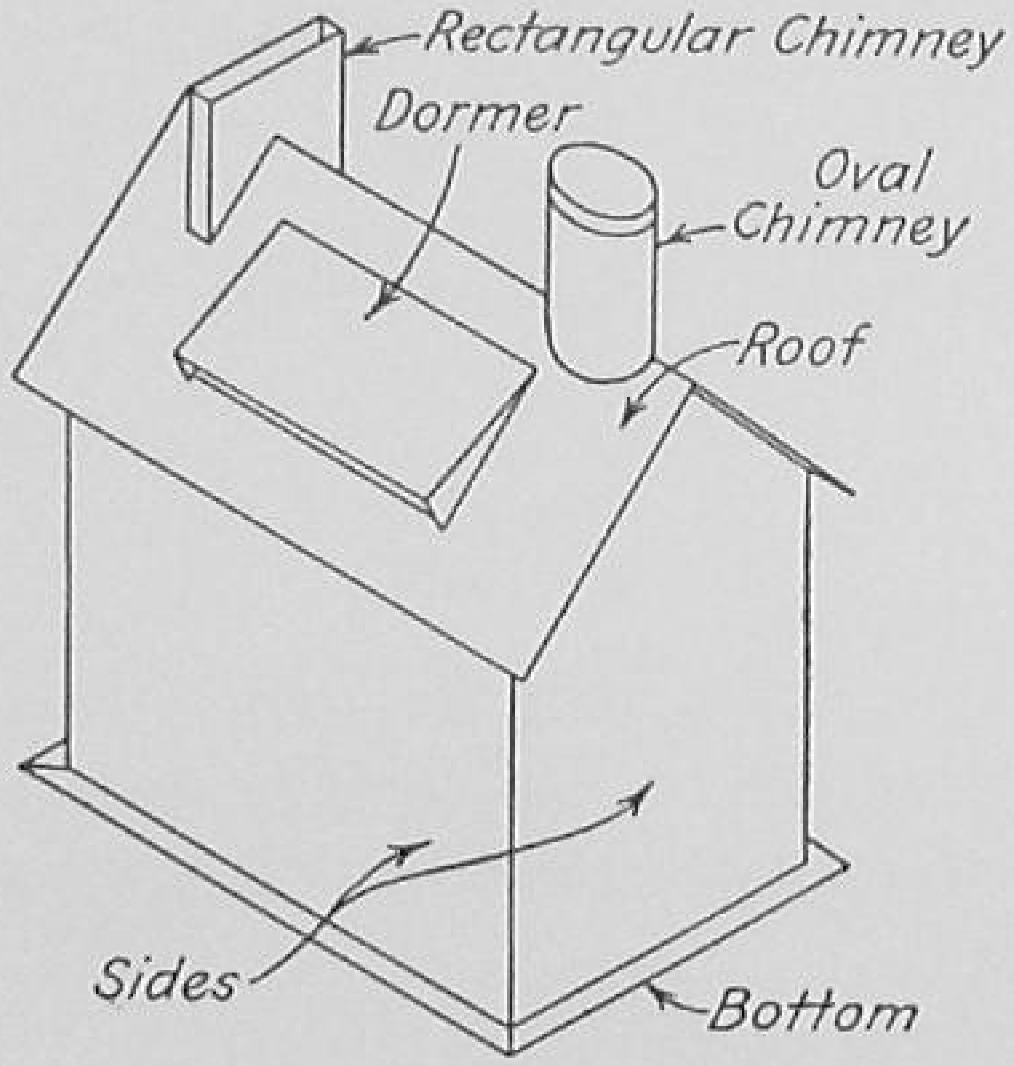
1. Prepare a blank 3 1/16″ x 4 3/8″.
2. Notch the corners as indicated.
3. Fold for bottom joint on three sides so that bottom may slide in place.

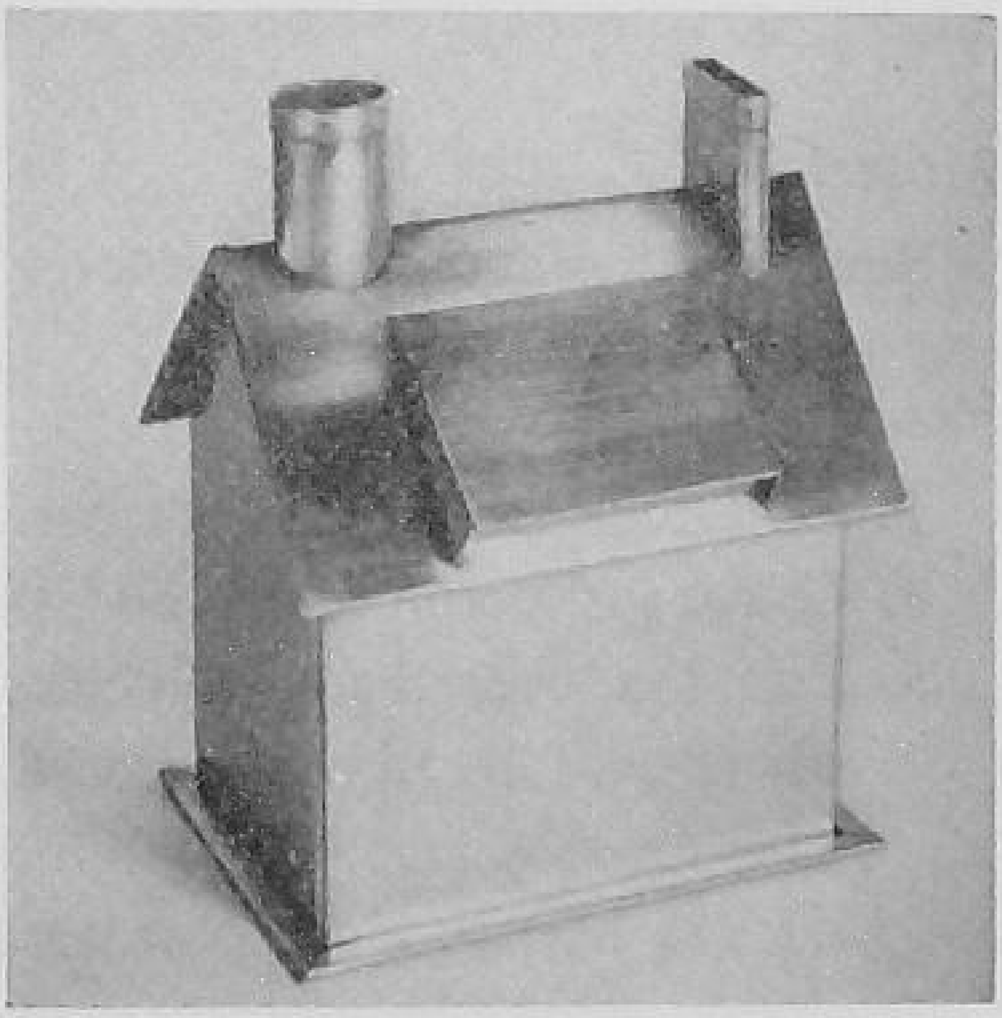
Dormer (two required)—1. Cut the blanks to dimensions. 2. Fold the edges over a stake. 3. Cut the dormer piece blank and solder it in place. 4. Solder the dormers in place on the roof.

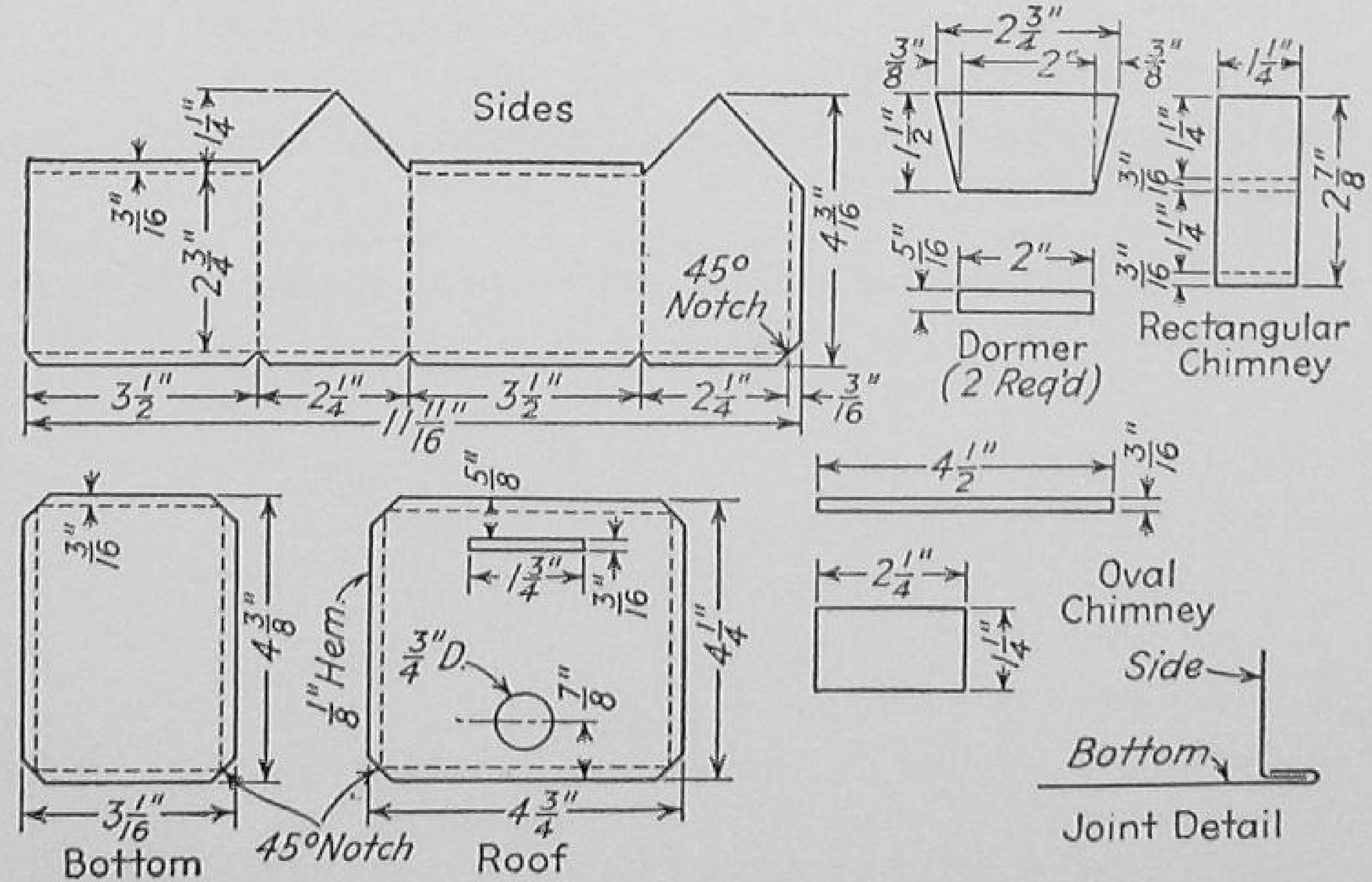
Oval Chimney—1. Cut out blank and form it to fit the hole in roof. 2. Solder the seam. 3. Cut out the top piece and form it around chimney. 4. Solder the top piece in place. 5. Solder the chimney in place on the roof.

Rectangular Chimney—1. Cut out blank and fold it over a piece of steel. 2. Solder the edge joint and solder it in place on the roof.

Assembly—1. Solder the roof on sides from the inside. 2. Slide the bottom in place and set down the seam with a hammer.







PROJECT 14.

PROJECT 15

Chasing Tools

The metalcrafter may well make his own chasing tools; thus he will be able to shape each tool to the particular shape for the job it is to perform. This project also provides the experience of working with tool steel.

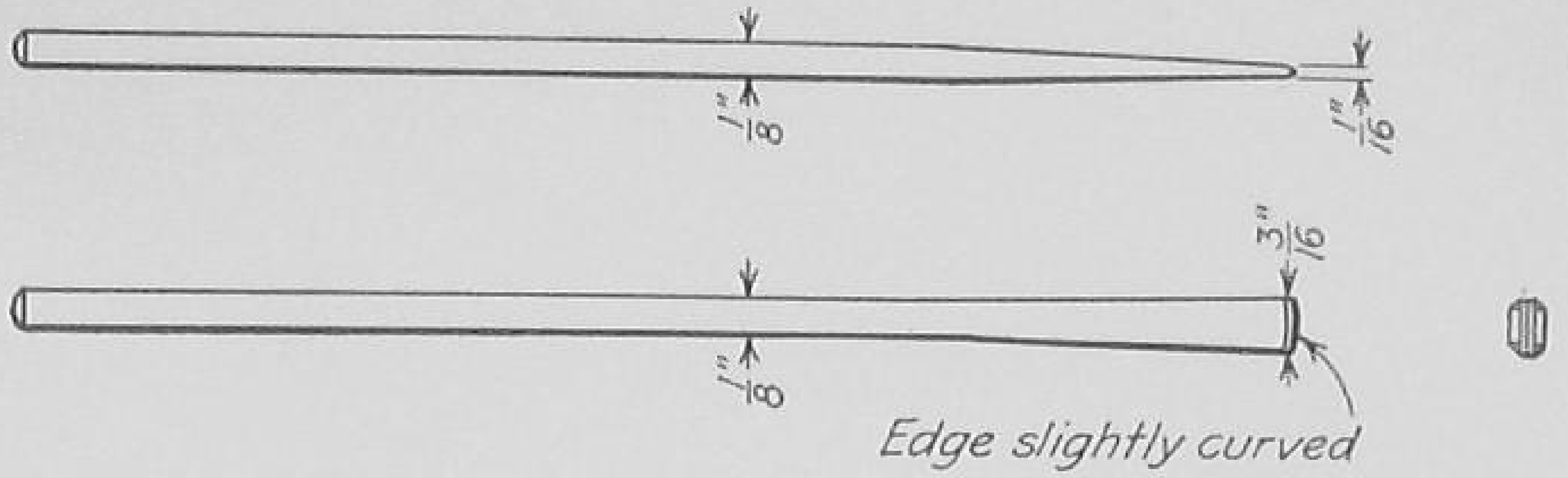
Material:

Square or octagonal tool steel, sizes as suggested in the drawing.

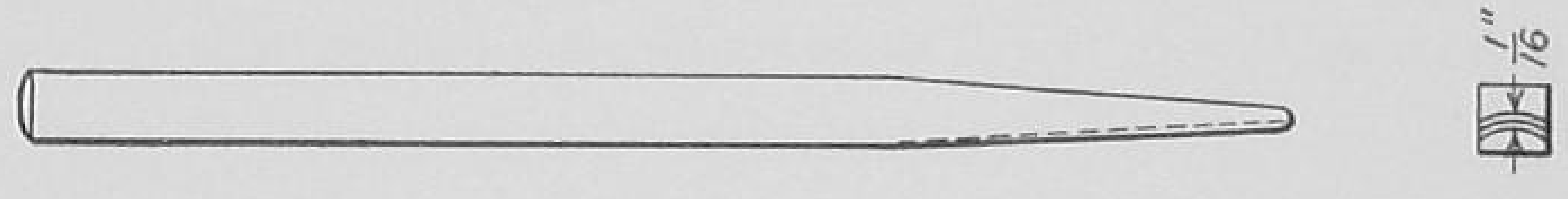
Procedure:

1. Cut stock to length with hack saw.
2. Crown or chamfer one end with a mill file.
3. File the other end to desired shape with a mill file. The curved tracer will require the use of a round file for the concave surface. The straight tracer may be forged to the taper required thus increasing the length of the resulting edge.
4. Polish all surfaces with #180 abrasive cloth.
5. Polish working areas with #240, and #320 abrasive cloth.
6. Harden and draw the temper to a straw color.
7. Repolish working surfaces with #320 abrasive and follow this with crocus cloth.

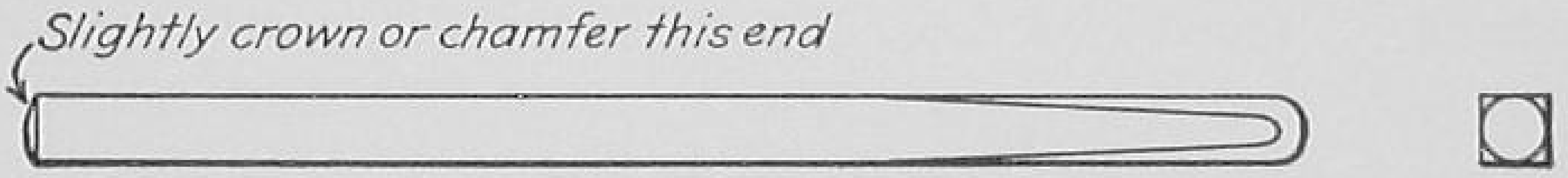
Note: To be effective, the working surfaces of all chasing tools should have a mirror-like polish.



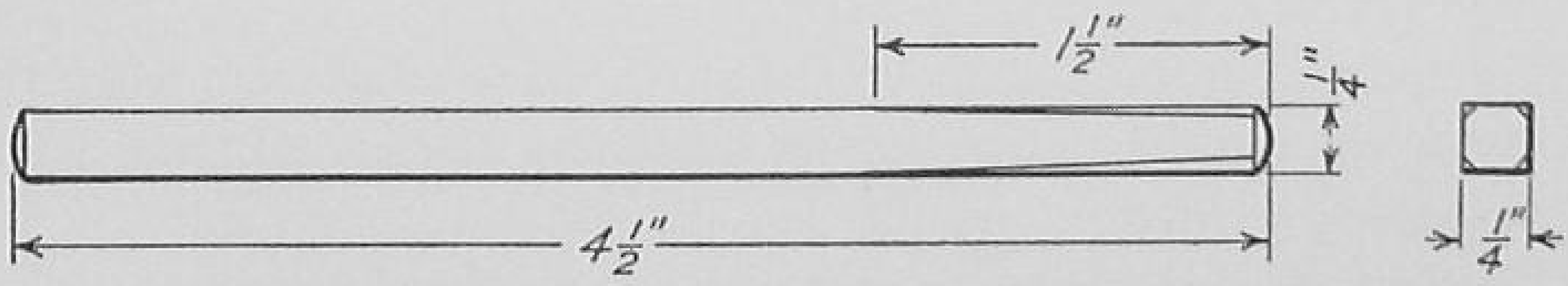
1. Tracer



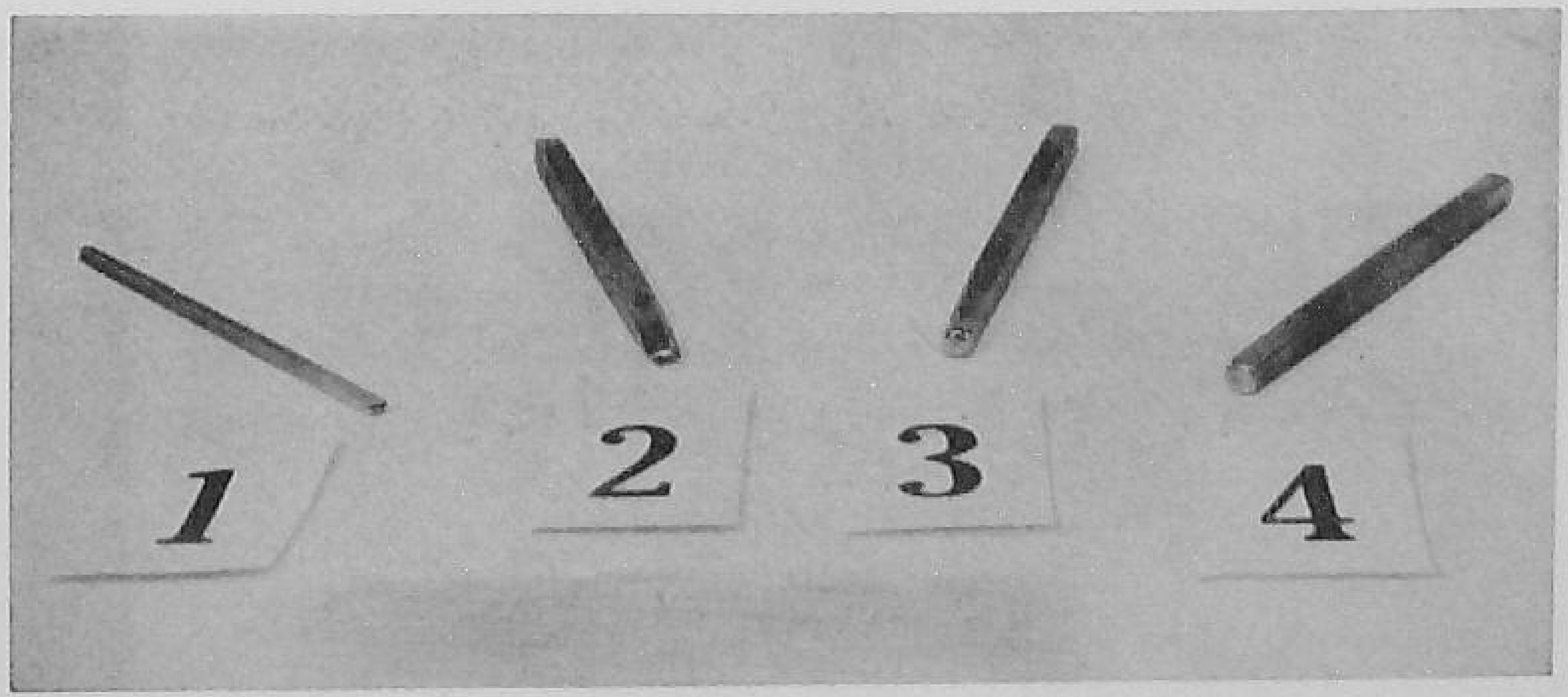
2. Curved Tracer



3. Rounded Planisher



4. Planisher



Project 15.

PROJECT 16

Plant Stand

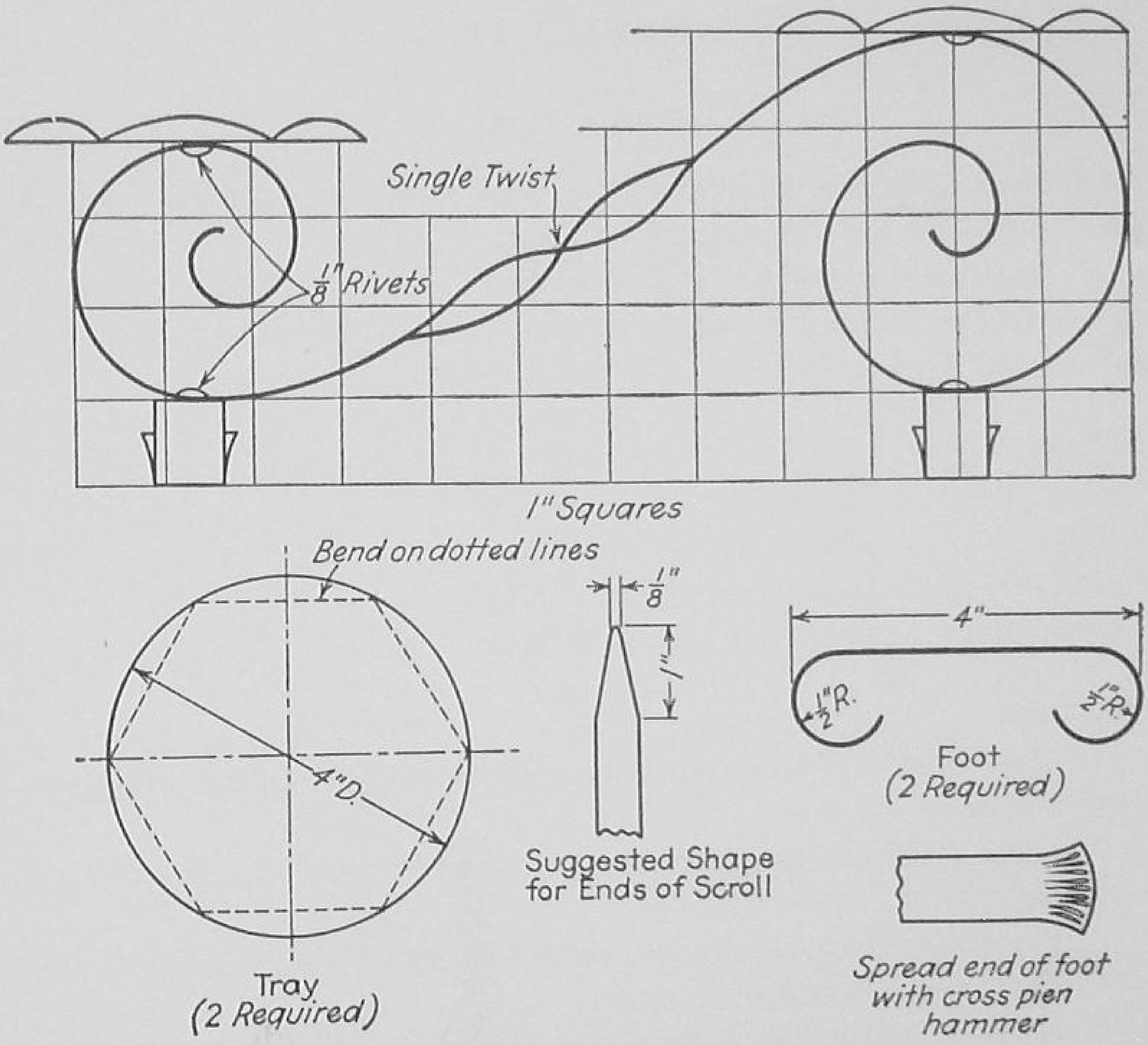
This plant stand will hold two small pots of ivy. An attractive arrangement may be made with two of these stands on a library table.

Material:

Scroll:	1 pc.	band iron, 1/8″ x 1/2″ x 30″
Foot:	2 pc.	band iron, 1/8″ x 3/4″ x 7″
Tray:	2 pc.	copper or aluminum 18 gage, 4″ D
Rivets:	4	round-head, iron, 1/8 x 1/4

Procedure:

1. Make a full-size layout of the scroll and feet on heavy paper.
2. Cut out material as indicated.
3. Lay out and shape the ends of the scroll piece to the suggested contour on the drawing.
4. Spread end of foot blanks on the anvil, using cross-peen hammer.
5. Bend the scroll in a bending jig beginning at each end and working toward the center.
6. Make a twist in the scroll as indicated on the drawing.
7. Bend the feet to shape over 1″ D steel rod held in a vise.
8. Lay out a hexagon on the 4″ D copper discs.
9. Fold the edges of the tray as indicated, using wooden blocks in a vise or the bar folder.
10. Locate and drill the holes for rivets.
11. Polish the trays and antique their surface if desired.
12. Rivet the trays and feet in place. *Note*: The natural oxidized finish on the band iron protects its surface from rusting and also leaves a pleasing dull finish; therefore, no additional finish is necessary.


Single Twist
1/8" Rivets
1" Squares
Bend on dotted lines
4" D.
Tray
(2 Required)
1/8"
1"
Suggested Shape for Ends of Scroll
4"
1/2" R.
1/2" R.
Foot
(2 Required)
Spread end of foot with cross pien hammer

PROJECT 16.

PROJECT 17

PIN-UP LAMP

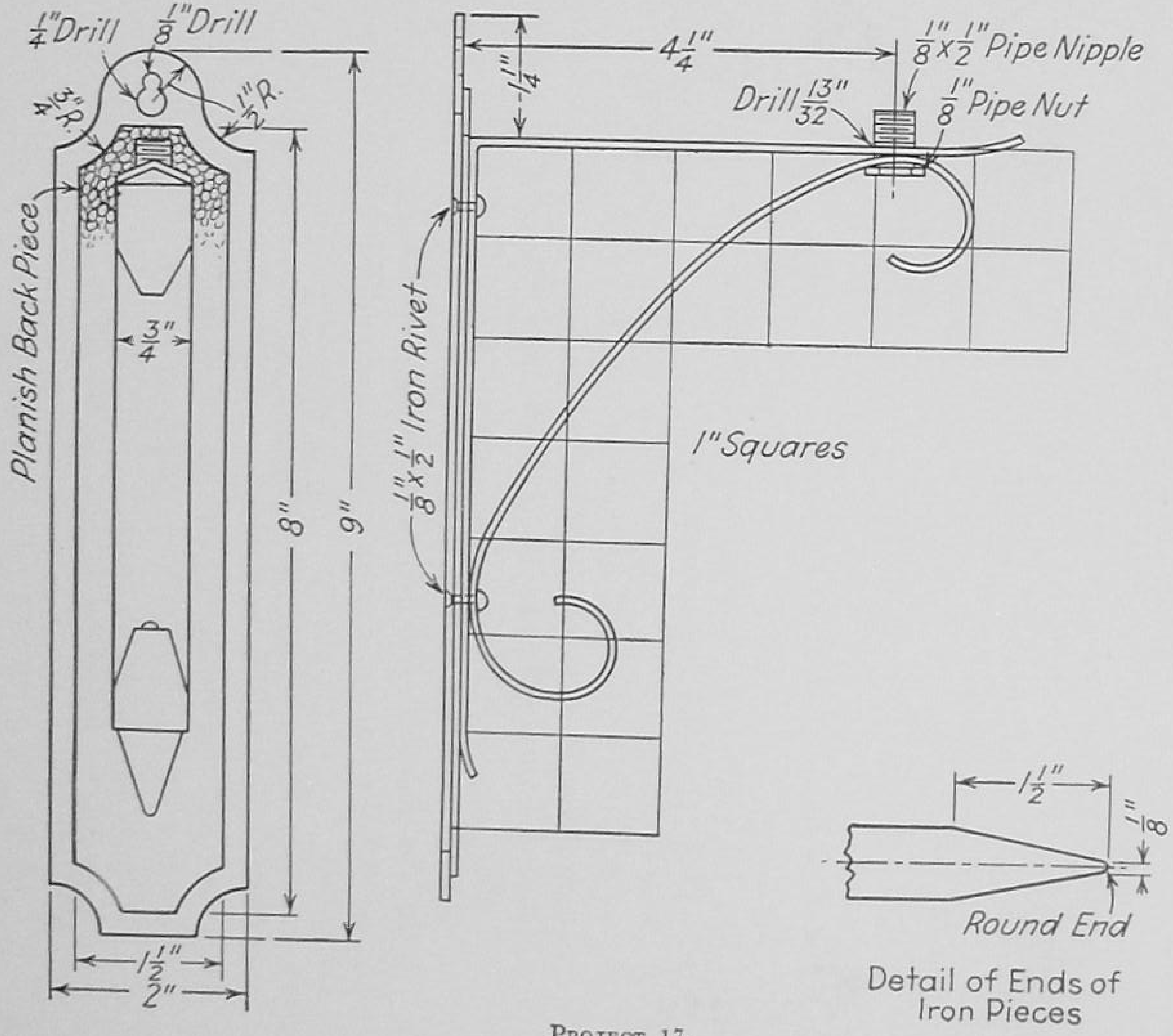
This wall lamp may be hung on any wall, providing an attractive ornament and useful light for reading or effect. It is designed to be used with an 8″ diameter shade which is clamped on to an 60- or 75-watt bulb. For instructions on wiring the socket and plug, refer to the *"Home Mechanic's Handbook,"* D. Van Nostrand Co., pp. 689-691.

Material:

Back piece:	Aluminum 1/8″ x 1 1/2″ x 8″
Back:	Aluminum 1/8″ x 2″ x 9″
Angle bracket:	Band iron 1/8″ x 3/4″ x 12″
Scroll brace:	Band iron 1/8″ x 3/4″ x 11″

Procedure:

1. Make a full-size pattern of the two back pieces from the drawing on a piece of oak tag.
2. Make a full-size layout of the scroll and bracket on a piece of oak tag.
3. Lay out and cut out the rectangular pieces for the back.
4. File the edges and ends square.
5. Using the pattern for a template, mark the radii on the corners.
6. Saw out three curves and file them with a half-round file.
7. Locate holes for hanging and drill them.
8. Polish the surface of the larger back piece with #120 abrasive cloth.
9. Planish the surface of the smaller back piece.
10. Cut the pieces of band iron for the bracket and brace.
11. Lay out the shape of ends on each and grind them to shape on the grinder.
12. Bend the 90-degree angle in the bracket and bend ends as indicated.
13. Bend the scroll on the brace.
14. Locate and drill the holes for rivets and socket.
15. Tap the thread in the hole for socket.
16. Assemble the parts with rivets.
17. Fasten the socket with a 1/8″ pipe nipple and nut.
18. Wire the socket and plug.


1/4" Drill
1/8" Drill
3/4" R.
1/2" R.
Planish Back Piece
3/4"
8"
9"
1 1/2"
2"
1/4"
4 1/4"
1/8" x 1/2" Pipe Nipple
Drill 13/32"
1/8" Pipe Nut
1/8" x 1/2" Iron Rivet
1" Squares
1 1/2"
1/8"
Round End
Detail of Ends of
Iron Pieces

PROJECT 17.

Hand Made Jewelry Section

BY

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INTRODUCTION TO HAND MADE JEWELRY SECTION

"Consider how many circumstances must favorably unite before the beautiful can emerge in all its dignity and splendor."

—*From the writings of Robert Schumann.*

All creative effort in the jewelry crafts can probably be classed in either of two categories: (1) The enrichment of a metallic surface, and (2) the manipulation of its form or contour. These two larger divisions may be broken into a series of basic techniques. The purpose of this book is to review these techniques so as to enable the aspiring craftsman to master them fully.

Just as the musician must master the difficulties presented by his instrument before he can divulge the innermost meaning of his music, so may the craftsman, by mastery of the techniques of his art, fully achieve creative expression without the limitations of a partially understood technique.

Years of teaching the art of the craftsman have made it possible for the writer to observe at first hand the habits and errors of the novice. In the text, therefore, it has constantly been the aim to supply those necessary hints and suggestions that are frequently so tantalizingly missing at other sources. Nowhere has the writer assumed the reader to be informed, experience-equipped craftsman in search of mere suggestions for designs. Where deemed advisable, several methods of procedure have been supplied, as different experienced workers have their individual preferences. Any one of these suggestions may be the answer to the novice who is dissatisfied with the results of the method he has been using.

Projects, as such, have been included only where they serve to illustrate a technique. A presentation of projects has a limited value; tastes change with time, and differ with individuals. A mastery of the techniques presented here, however, will make it possible to understand as well as plan the procedure for limitless numbers of objects of jewelry.

To study a technique, the author suggests the following procedure:

1. Read with care the information presented in any unit.
2. Apply the reading to actual practice.
3. Reread the text immediately after the practice.

This procedure has been found to be the most effective means of completely assimilating the text.

IV. HAND MADE JEWELRY SECTION

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Chapter I

THE JEWELER'S SAW

•

Chapter II

TRANSFERRING THE DESIGN TO THE METAL

•

Chapter III

FILES, FILING, AND ABRASIVE TOOLS

•

Chapter IV

SOFT-SOLDERING

•

Chapter V

HARD-SOLDERING

•

Chapter VI

PICKLING, PICKLING SOLUTIONS, AND ANNEALING

•

Chapter VII

BUFFING, POLISHING, AND LACQUERING

•

Chapter VIII

DIPS AND OXIDIZING OR COLORING SOLUTIONS

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Appendix
THE PROCUREMENT OF SUPPLIES

Chapter I

THE JEWELER'S SAW

Probably the most often used tool in the field of hand jewelry is the jeweler's saw. This tool consists of a saw frame and a fine-toothed blade.

The Frame.

The frame resembles somewhat a fretsaw or coping saw. It is made of a good grade of steel, tempered properly so as to have some degree of "spring" to it. A good quality frame should be used. These saw frames vary in depth—that is, the distance from the saw blade to the back of the frame. Depths vary from about 2¼″ to 12″. A 3″ frame is a good size for jewelry. For work on bracelets made of 6″ to 8″ strip, a 4″ frame may be desirable. The distance between the two clamps on the frame is variable, making it possible to utilize blades that have been made shorter through breakage. The standard blade length is 5″. The clamps on the frame are made tight by thumbscrews and it should *not* be necessary to use pliers on them.

The Saw Blade.

Jeweler's saw blades are available in various sizes. The size refers to, though it does not literally indicate, the number and size of the teeth on the blade. The length is always 5″. Sizes used by jewelers run from about No. 2 to No. 8/0. No. 2 is the coarsest, 8/0 the finest, numbers running 2, 1, 0, 2/0, 3/0, etc.

These blades should be of fine, tempered steel. The two end portions without teeth are tempered differently from the cutting portion. The end portions are somewhat softer, in order to withstand the strain and flexing stress at the clamps. The middle cutting portion is tempered very hard, so as to cut metal, and is rather brittle. When the end portions of the blade break, many users shorten the frame and continue to use the remaining saw blade. This may be done, but the frequent breakage which then occurs is due to the breaking of the *brittle* cutting portion of the blade which is now in the clamp.

The choice of blade size depends upon the thickness of the metal to

be cut, and to some extent on the intricacy of the design. For No. 18 gauge metal, a No. 1 blade will suffice. This is probably the most commonly used blade size. Actually, although this practice is not assiduously followed, blades are selected according to the following rule: Note *A* and *B*, Fig. 1.

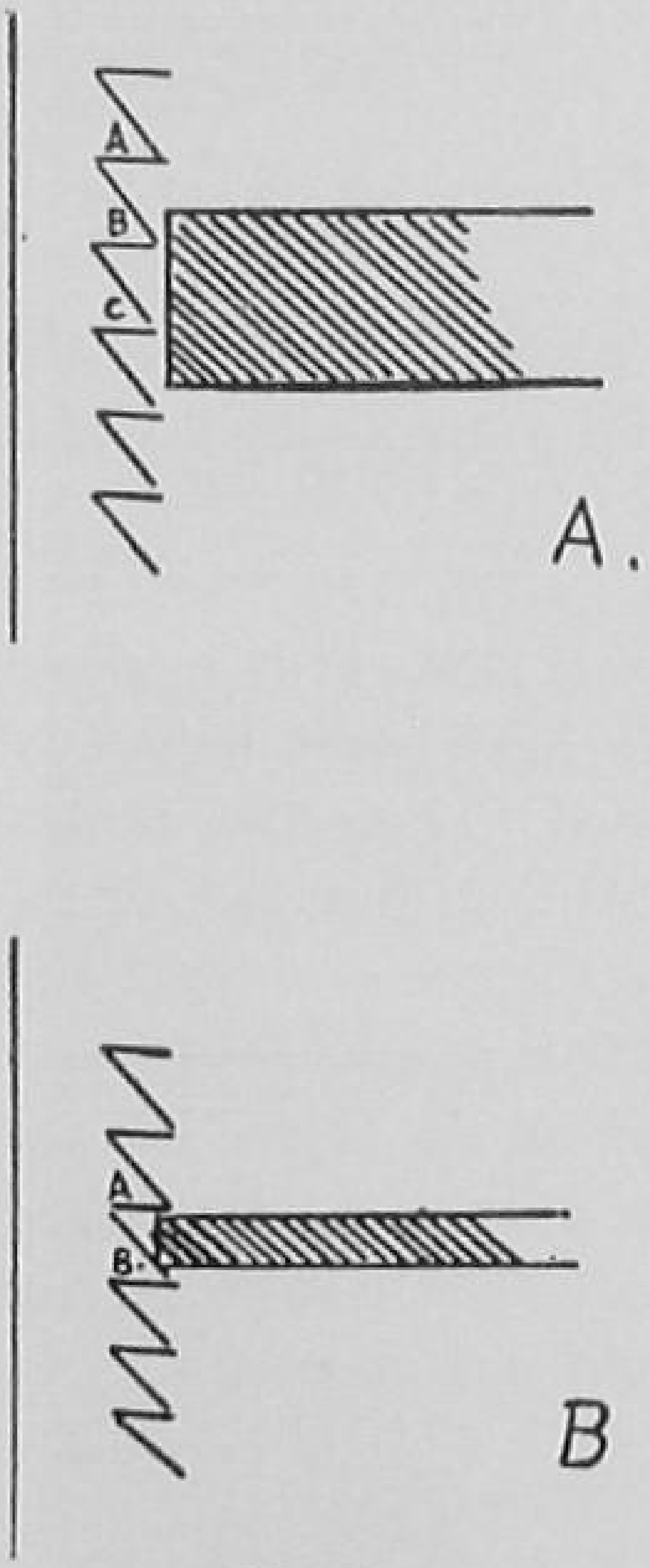


FIG. 1

In Fig. 1*A*, teeth *B* and *C* are in contact with the metal being cut. This means the metal cannot become caught between teeth since when tooth *C* leaves the metal, tooth *A* and *B* are in contact.

In Fig. 1*B*, which shows incorrect practice, the blade size selected allows the metal to become caught between teeth *A* and *B*. Operation of the saw then becomes very jerky, with frequent blade breakage and coarse results.

Using the Saw.

To mount the blade, loosen the thumbscrews on the clamps one or two turns. The frame should be set so that the distance from the center of one thumbscrew to the center of the other is about equal to the blade length. The frame is then held as shown in Fig. 2, and one end of the saw blade is clamped in the upper clamp. The blade should be held so that the teeth point outward from the frame and toward the handle. This permits the teeth to do their cutting on the down, or pull, stroke. When one end of the blade is tight, lean the body forward against the handle so as to bring the two clamps on the frame toward each other. The lower end of the blade is quickly set into its clamp, which is made tight, and body pressure is released. Plucking the blade lightly with the finger should produce a clear musical tone if the job has been properly done.

If a blade persistently slips out of the jaws of the clamp, do not condemn the saw frame until you have opened the clamp entirely and inspected the inner surfaces. A piece of saw blade from a previously broken blade sometimes lodges in the clamp and prevents the application of full pressure on the new blade. If this is so, remove the obstruction and repeat the mounting procedure.

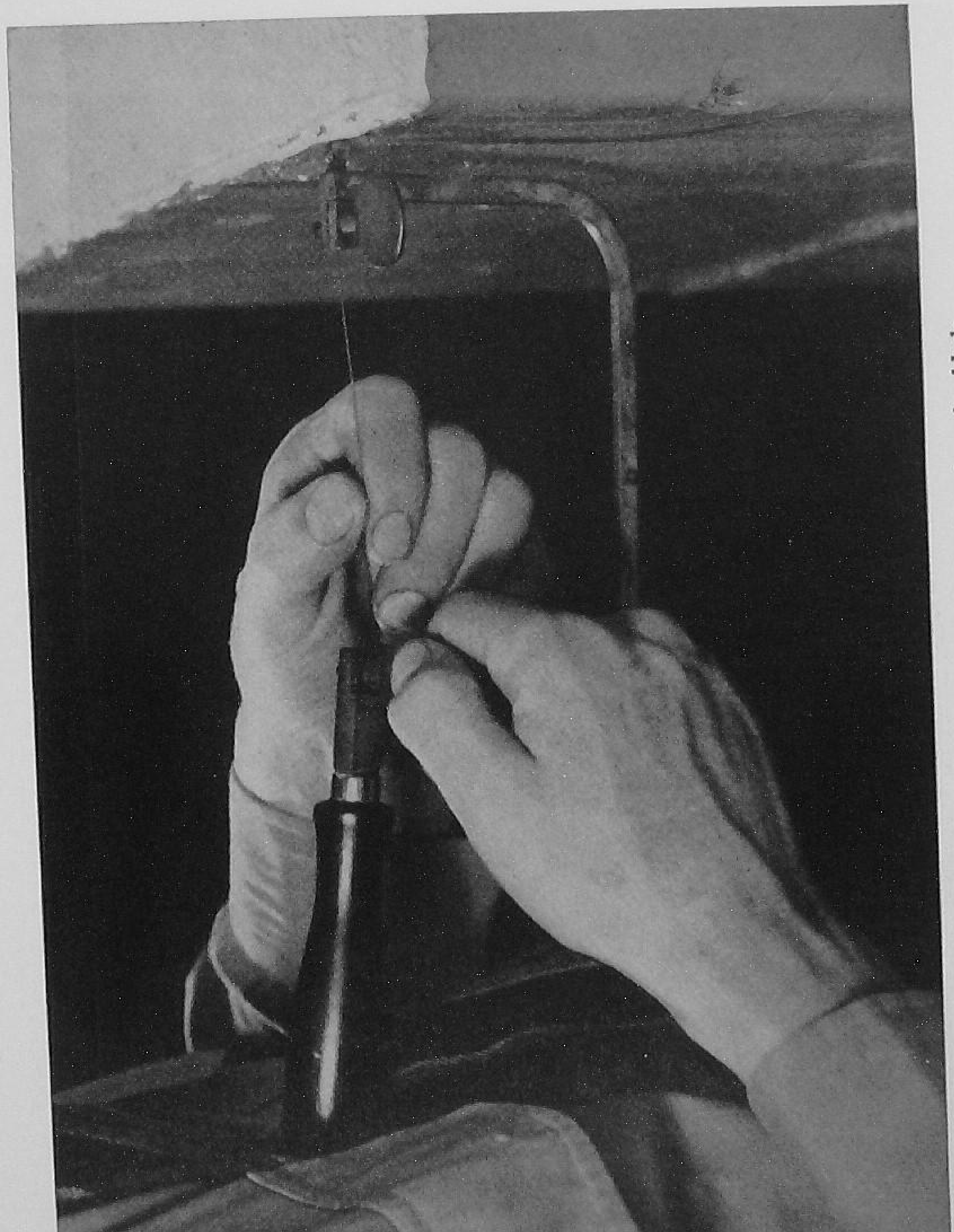


FIG. 2. Holding the saw-frame for the insertion of a blade.

FIG. 3. Correct position for sawing.

With the jeweler's saw properly rigged, attention must be paid to the V block, or bench pin. This should be mounted at a height which will allow the forearm to be approximately horizontal or parallel to the floor when the saw is held against the work, with the work at the blade's midpoint (Fig. 3).

If the bench height is not exactly right, remember that the stool upon which the worker is seated may be varied in height. The work should be held against the V block with the fingers, striving for fullest possible support and rigidity.

The blade should be perpendicular to the work. The saw motion should be up and down, with the faintest emphasis on the down, or pulling, stroke, since this is the stroke that cuts. Avoid forward pressure—the saw will seemingly feed itself. Additional pressure will only clog the teeth and make sawing more difficult and breakage more frequent. The spaces between each of the teeth determine approximately the amount of removed metal the blade will accommodate.

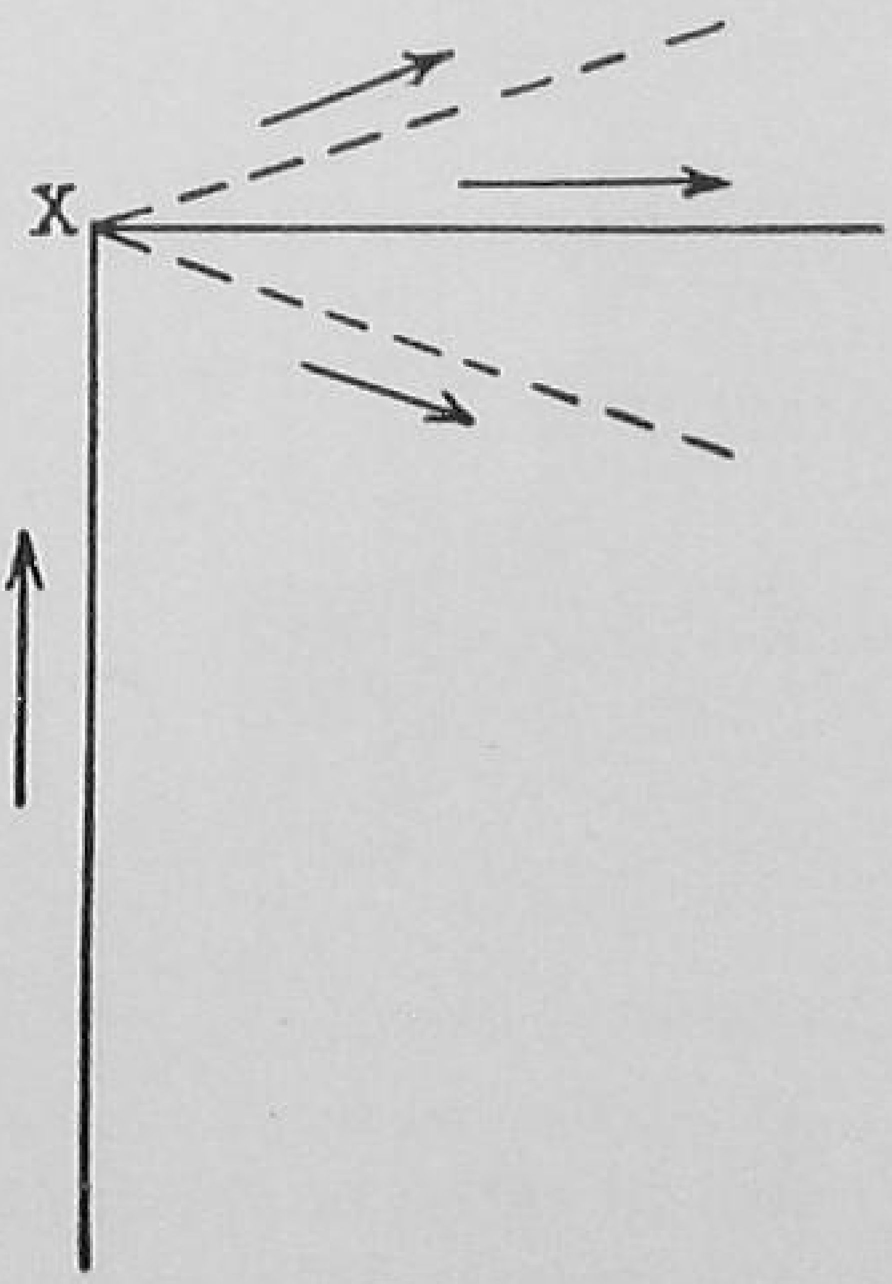


Fig. 4.

Forcing the blade forward will only choke the saw. Maneuver around curves naturally, just as one maneuvers a bicycle. *Angular* changes in the direction of sawing are more difficult and require a special technique. When a cut is to be made at a right angle, for example, cut down along the line until the point is reached where the change in direction is to occur. In the diagram (Fig. 4), this is point *X*. If one mentally likens this procedure to a boy marching in a gymnasium, assume the boy to march in the direction of the arrow. Stop at point *X*, and "mark time" in place. This means the saw will be moving up and down at this point, without forward progress. Now the boy, continuing "to mark time," slowly turns a full 90 degrees until he is facing the new direction squarely. He then marches off. The saw, likewise, is *slowly* turned toward the new direction, continuing its *normal* up-and-down motion without, however, any forward progress. When facing the new direction, the saw progresses along this new path in the usual manner. The author has found that by actually

using a pupil marching on a chalk line in the classroom a most effective demonstration of this technique is made.

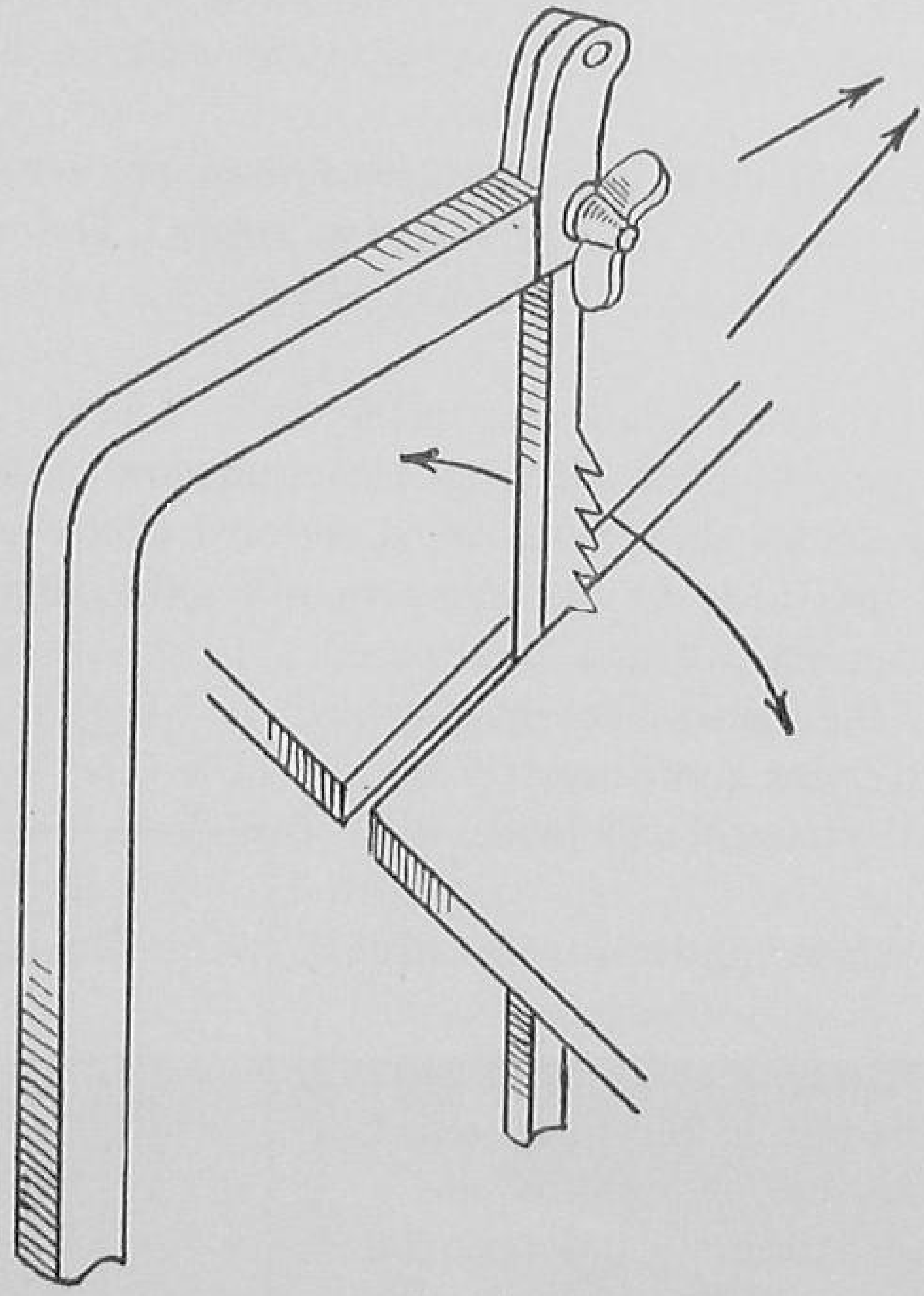


Fig. 5.

Sticking Saw Blade.

If the saw seems to stick at some particular point during sawing and resists all efforts to dislodge the blade, abandon all forcible attempts to free it. It will usually be found that the saw frame is not pointing in the same direction as the saw kerf. This results in wedging the corner of a saw tooth diagonally in the kerf (see Fig. 5). To free the blade, exert a slight upward pressure and move the frame through an arc until the saw tooth, facing the proper direction, frees itself. If necessary, free the lower end of the blade from its clamp.

Delicate Trimming.

Mention of the saw blade's "tooth-corner" action brings up an important usage of the blade. When delicate sawing is done, and it is impossible to

find files small enough to trim up the final results, a fine-toothed blade may be utilized in the following manner: Insert the blade as usual and utilize the blade as a fine file by bringing a slight sideways pressure against the kerf. If the saw is turned very slightly so that the tooth corners tend to cut against the metal, a very delicate job of trimming can be accomplished. By using a blade somewhat finer than the one used for the original job, the tendency for the teeth to "wedge" in the kerf will be eliminated.

Piercing.

When metal is to be removed from inner portions of a design, small holes must be drilled in the portions to be cut out. These holes are drilled after they have first been located away from the line of the design and punched lightly, using a center punch and a light hammer. The work should be placed on a steel plate or anvil and the punch mark should not be so deep as to leave a noticeable mark on the reverse side. The slight dent made by the punch will prevent the drill from "walking" off the design and making a hole at the wrong location. The work is then removed from the steel surface and the holes drilled. Assuming the frame to be

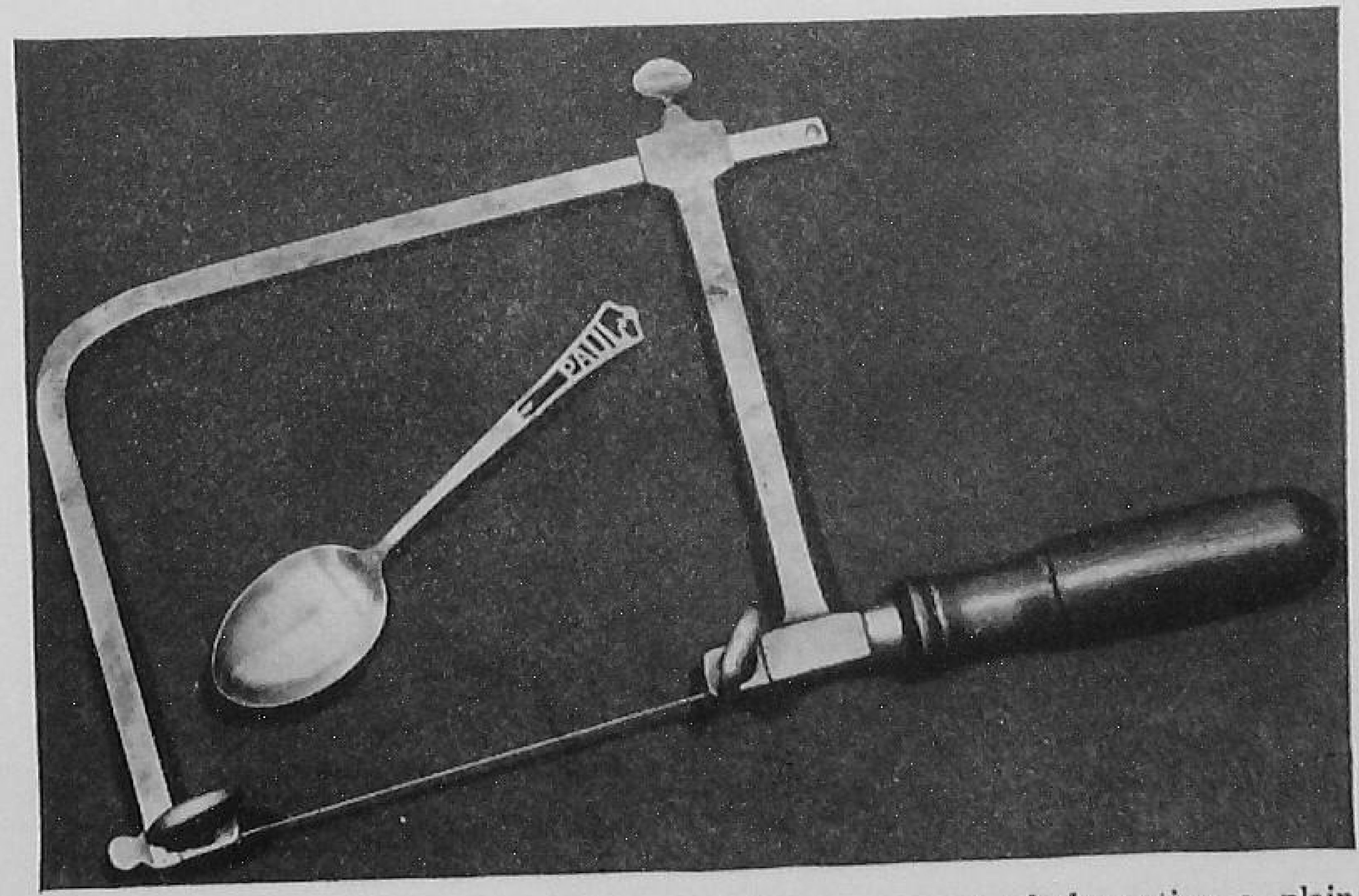


Fig. 6. An example of saw-piercing as well as a means of decorating a plain silver spoon.

rigged, release one end of the blade, thread through the hole, and move the work close to the tightly clamped end. The other blade-end is reset in the usual manner. This type of "internal" sawing is called *piercing* (Figs. 6, 7, and Frontispiece).

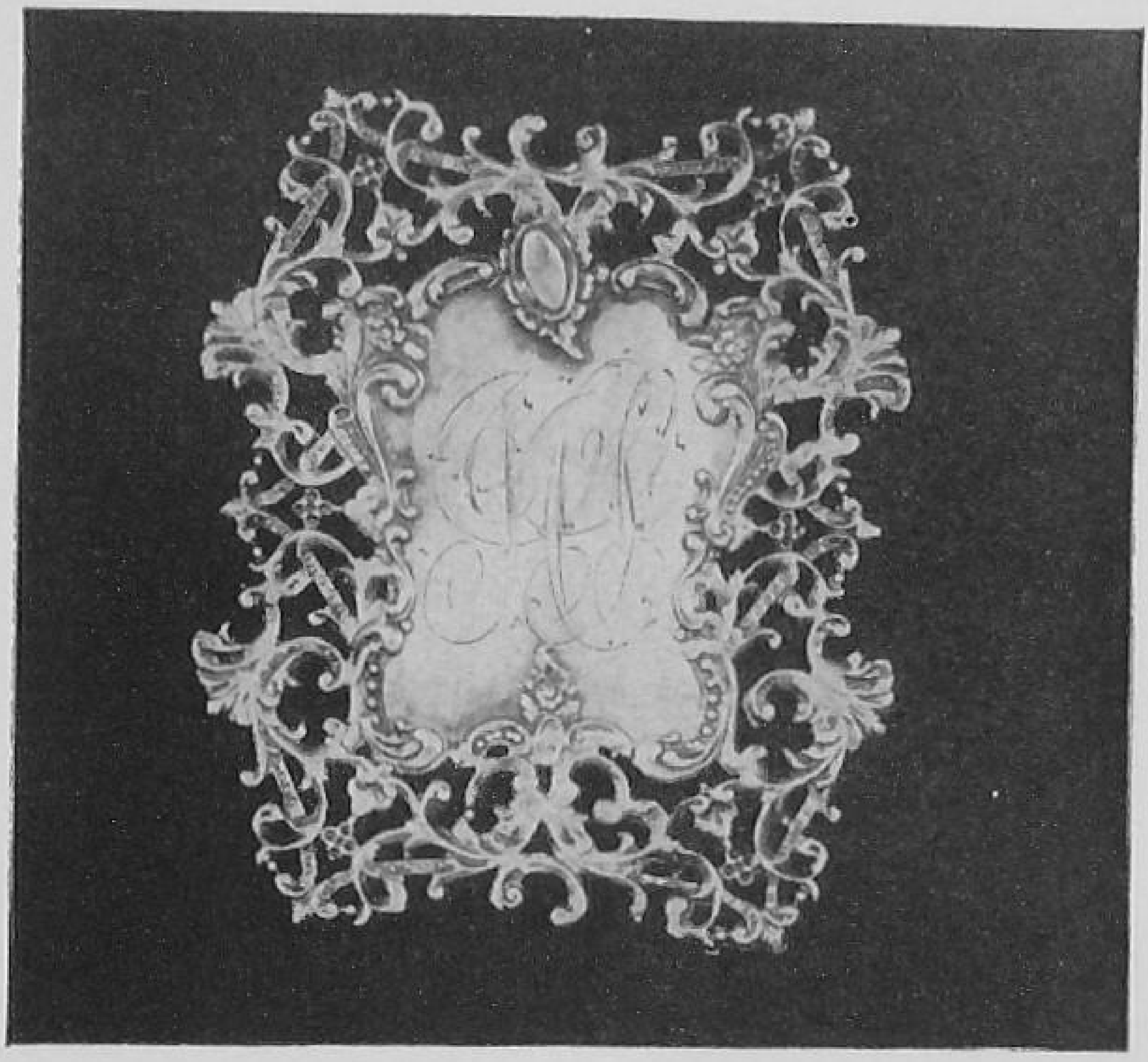


Fig. 7. Example of pierced and carved work.

Additional Hints.

For success in using the saw, the following further suggestions are offered:

As a lubricant on the saw blade, use beeswax or paraffin. Soap is sometimes used, but because it holds moisture it may cause rusting and consequent weakening of the blade. Draw the saw once down the cake of wax. Repeat when saw seems to "stick" frequently. A blade used with wax will pick up tiny particles of metal. The metal and the wax will fill the spaces between the teeth. This will give the appearance of a blade with no teeth. Do not be fooled by this appearance, as a blade in this condition will continue to cut quite well.

It is not necessary to rest the blade to allow it to cool.

When cutting out a design, the saw kerf (as the actual cut is called) follows *alongside* the line of the design. It is not necessary to leave a space

between the blade and the line. However, the line must *not* be removed and should readily be seen on the work after sawing is completed. Good saw work necessitates only the slightest use of the files for smoothing. Space left between line and blade means actual *hours* wasted filing to the line.

When a zig-zag or jagged outline is to be sawed, first saw to a curve around the points of the outline, as shown in the diagram (Fig. 8). When this has been done, cut straight in from the edge to the bottom of the **V.** Then back out the saw blade and use *either* of these techniques:

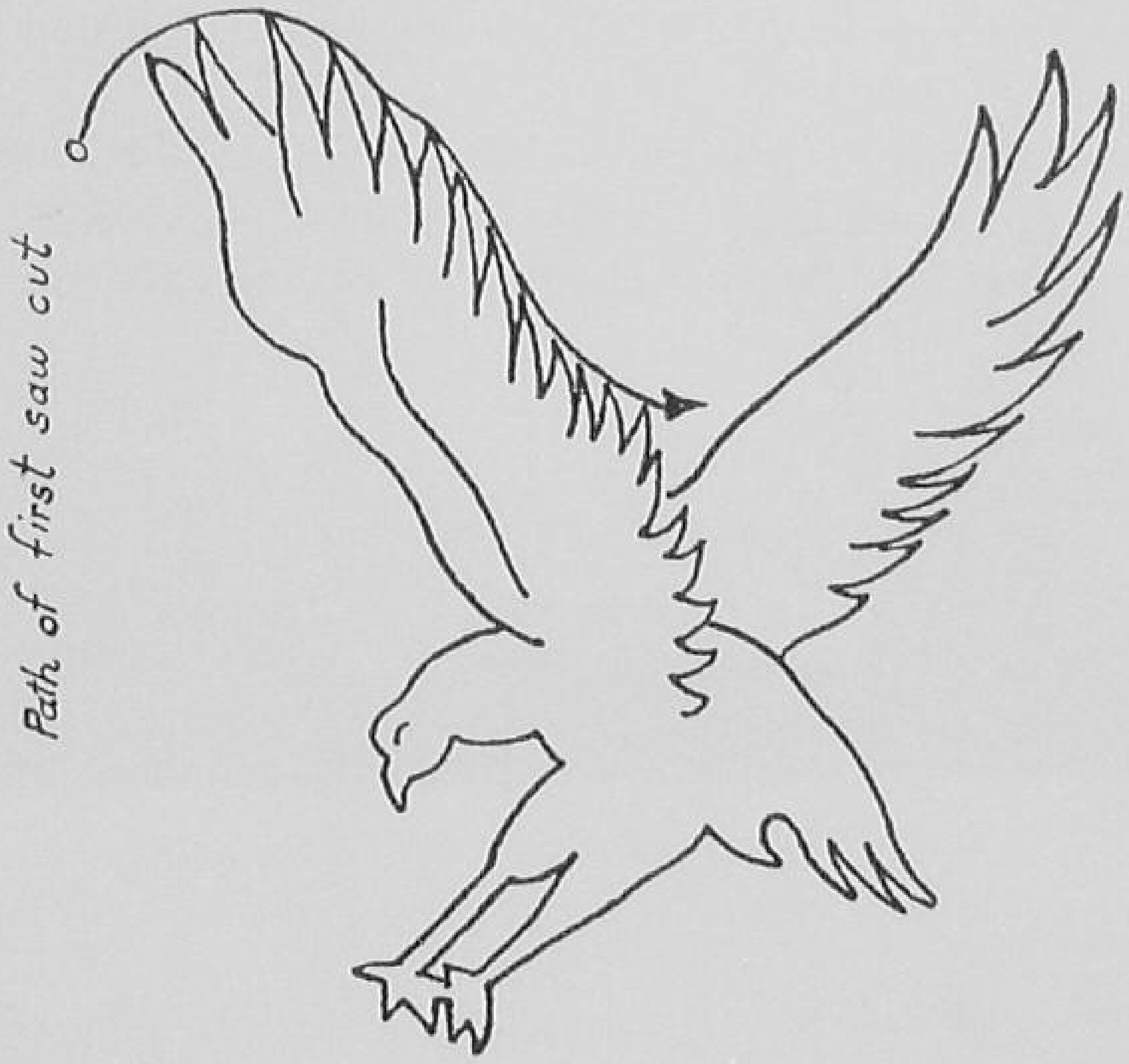


FIG. 8.

1. Cut from the next point in to the same V bottom, completely removing the portion in between the sides of the V.

2. *Back* the saw blade into the first V cut made, and when the bottom of the V is reached, turn the frame slightly and saw out along the next side of the V. This is a useful technique to remember.

If it is necessary to stop work momentarily for any reason when sawing, bring the upper clamp down to the work and the blade will be less likely to snap when the frame is moved, either through accident or when starting to cut again. If work on a complicated design must be stopped for the day

before the sawing is completed, rather than back out the blade along a lengthy and complex route, open the upper clamp so as to release the blade and pull down the frame, releasing the saw from the work.

Remember when backing out of a cut line, move the saw frame up and down just as if forward sawing were going on, only pull backward and follow the kerf carefully.

Always sit directly behind the saw frame. Turn the *work* when necessary, *not* the saw frame.

The beginner will find that fingers holding the work will tire before the sawing arm. Rest the fingers. Never clamp the work. It is not necessary to grasp the frame handle tightly. This tires the forearm, and makes cutting no easier.

There is a tendency to use the middle portion of the blade, actually utilizing about an inch of blade. Remember that 2″ of blade will cut twice as much metal, and the blade has about 4″ of cutting edge available!

Chapter II

TRANSFERRING THE DESIGN TO THE METAL

Several methods are available when it is necessary to transfer a design to the surface of a piece of metal. The most satisfactory of these involves the use of white tempera paint, carbon paper, and tracing paper.

Most of the work in jewelry will necessitate transferring a design to a flat sheet of metal. Two methods are recommended. Method 1 calls for a perfect drawing of the design. This may be done with the help of thin, hard, tracing paper and a sharp-pointed, medium-grade pencil. The completed drawing or tracing must be glued to the metal surface. Before this is done the metal surface is thoroughly cleaned with steel wool. Select a good hide glue or fish glue. Pharmacists use an excellent glue to attach their labels to bottles. Such a glue is useful, for the non-porous surface of a glass bottle is somewhat similar to the surface of smooth metal. Having selected the glue, apply it *very thinly* to the underside of the *paper drawing* or *tracing*. Apply the drawing to the metal and smoothe. If too much glue is applied, the design will require much time for drying and, more important, the applied drawing will later curl off the metal surface. The use of rubber cement is inadvisable. Designs applied with such cement will not remain in place, but will "creep" over the metal surface and occupy another position.

When the glue is dry, carefully go over the penciled lines of the drawing with ink, preferably waterproof. If this is not done, the drawing will rub off the paper during handling. Paper remaining on the metal may be removed later by using hot water.

The first method has its limitations when designs are to be transferred for etching purposes. In such circumstances, the design must be applied directly to the metal surface. This may be accomplished by first coating the surface with white tempera paint, or Chinese white. Coat the surface only after it has been scrubbed with steel wool. When scrubbed, dip the finger in a thick, white tempera paint, or rub the dampened forefinger on a cake of Chinese white. The paint-carrying finger is then rubbed firmly over the metal surface. The object is to deposit a *thin,* dull layer of paint

to the metal. Do not be disturbed by a streaky appearance so long as the metal is completely covered.

When the paint has dried *thoroughly,* place a piece of fresh carbon paper over the coated metal. Over this, position the drawing to be used and fasten both pieces of paper with small tabs of masking tape. Go over the drawing with a hard pencil. When the papers are removed, a perfect tracing will be found on the coated metal surface. This tracing must now be transferred to the metal, as the paint is to be washed off before the etching ground is applied. Using a well-sharpened scriber, the carbon lines are traced through, so that they are carried by the metal surface. Wash the paint away with water. The clearly cut design is now ready to be worked upon, or painted over with asphaltum if etching is to be done.

NOTE: The use of carbon paper over a bare metal surface is rarely completely successful.

A somewhat similar method may be used when the craftsman is artist enough to draw directly on the coated metal with a scriber, or when a pattern is to be applied with a scriber and steel ruler. This method eliminates the carbon paper. The metal is merely coated with a layout stain, such as used by machinists. The stain, usually methyl violet in a cellulose solution, is available at machinist's supply houses. It may be made by adding methyl violet to a solution of metal lacquer, considerably thinned with lacquer thinner. This solution is brushed on and dries in a few moments. Lines are scratched on the metal, through the stain, and will appear brightly in contrast to the stain used. When all drawing is done, the stain may be removed by wiping with cotton dipped in lacquer thinner. Some types of layout stains may be removed with alcohol.

Chapter III

FILES, FILING AND ABRASIVE TOOLS

Selecting and utilizing the proper file for a piece of work are important factors in hand jewelry making that are too often only partially understood. Although the file does shape the metal to some extent, it is not usually used for that particular purpose. Rather it is used for finishing and smoothing and for slight changes in metal objects.

Files, other than jeweler's or needle files, consist of a toothed cutting portion ending in a pointed tang, which is driven into a wooden handle of proportionate size. Needle files and escapement files have a rounded,

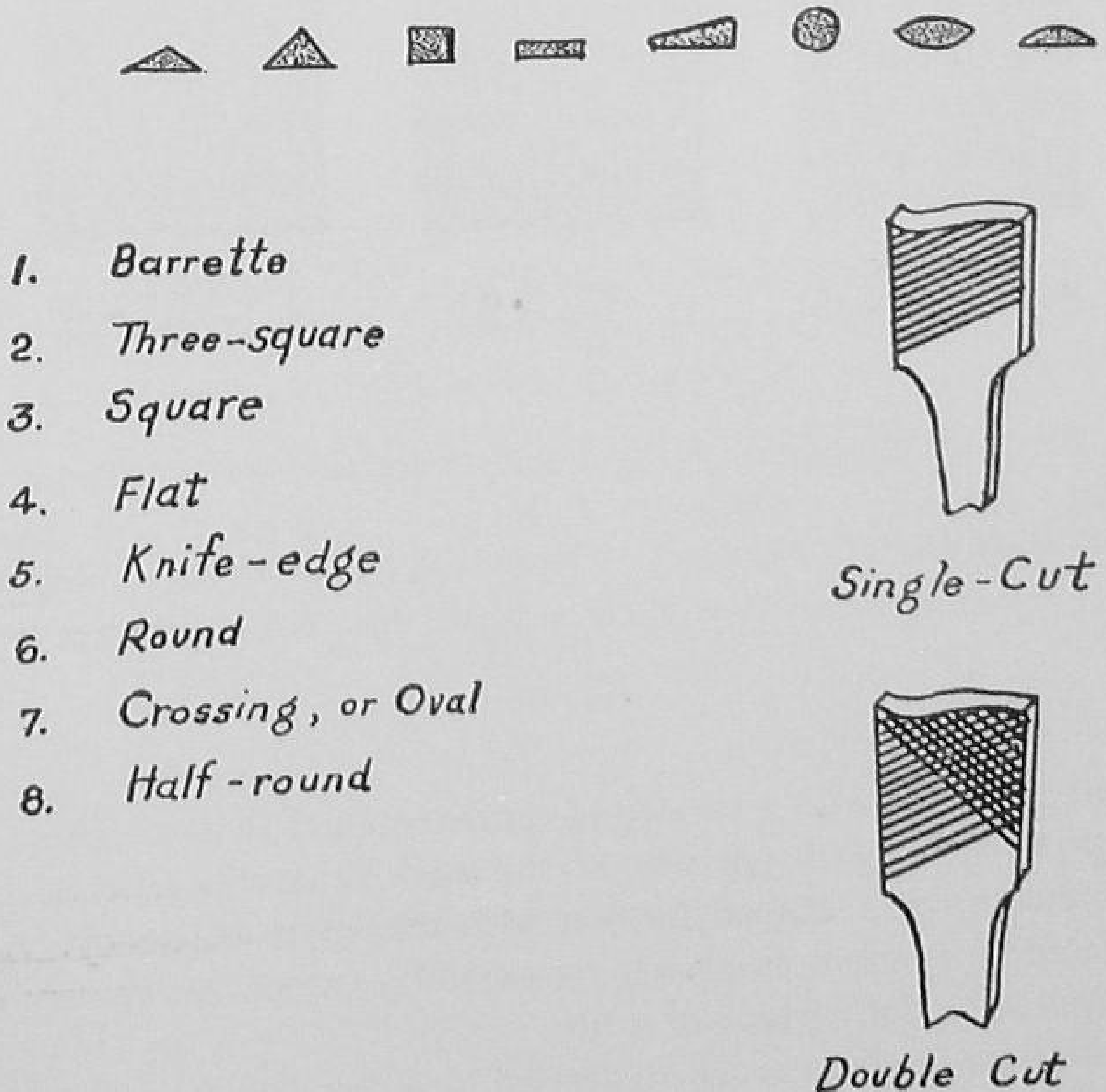
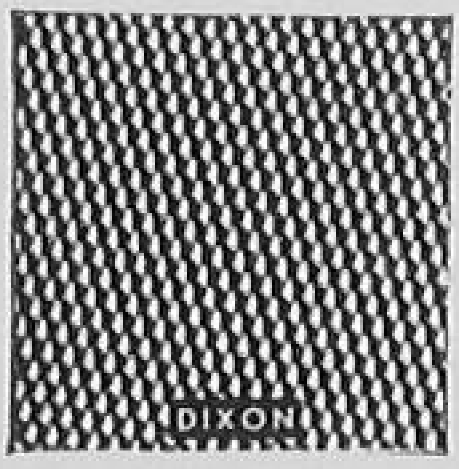


Fig. 9.

smooth, unpointed metal end which replaces the tang and forms a convenient handle. Files come in a variety of sizes and cuts. The length of a tanged file is measured by the *cutting length.* A self-handled needle file is measured according to over-all size. The cut may be either single or double cut (see Fig. 9) and the tooth size is also considered when referring to the cut, *e.g.*, No. 2 double-cut (see Fig. 10).



No. 00
27 Cuts to Inch

No. 0
34 Cuts to Inch

No. 1
42 Cuts to Inch

No. 2
98 Cuts to Inch

No. 3
110 Cuts to Inch

No. 4
144 Cuts to Inch

Permission of Wm. Dixon Inc., Newark, N. J.

These Cuts Compare with the Regular American Files as Follows:

GLARDON	No. 00	No. 1	No. 2	Nos. 3 or 4
REGULAR AMERICAN	Bastard	Second Cut	Smooth	Super Smooth

Note: For cuts numbered from No. 4 to No. 6 there is no equivalent in Regular Files.

Fig. 10.

Files are available with a variety of cross-sectional shapes. These shapes make it possible to reach portions of the work otherwise inaccessible and also to smoothe out a shaped portion with maximum efficiency. A file is always fitted to a curve as closely as possible, except for convex curves, which require the flat surface of a file.

Riffle files are used to reach depressed or otherwise inaccessible areas. These files are double-ended and bent. If a riffle file is unavailable when

needed, it may be made by taking a needle file of the required cross section, heating it in a flame until orange in color, and pressing the heated point against a steel block, bending it to the required curve. Do *not* attempt to bend the file if it loses its heated color, but instead, re-heat. When the required curve is achieved, heat to red heat and plunge the file quickly into cold water. The resulting riffle file will not be as fine a tool as a commercial riffle file, but it will serve well in an emergency.

Filing is the removal of metal by passing a series of short, chisel-shaped teeth over it. Because of the angle of the teeth, a file will cut *only* on the *push* stroke. This is very important, because *pulling* the file over the work

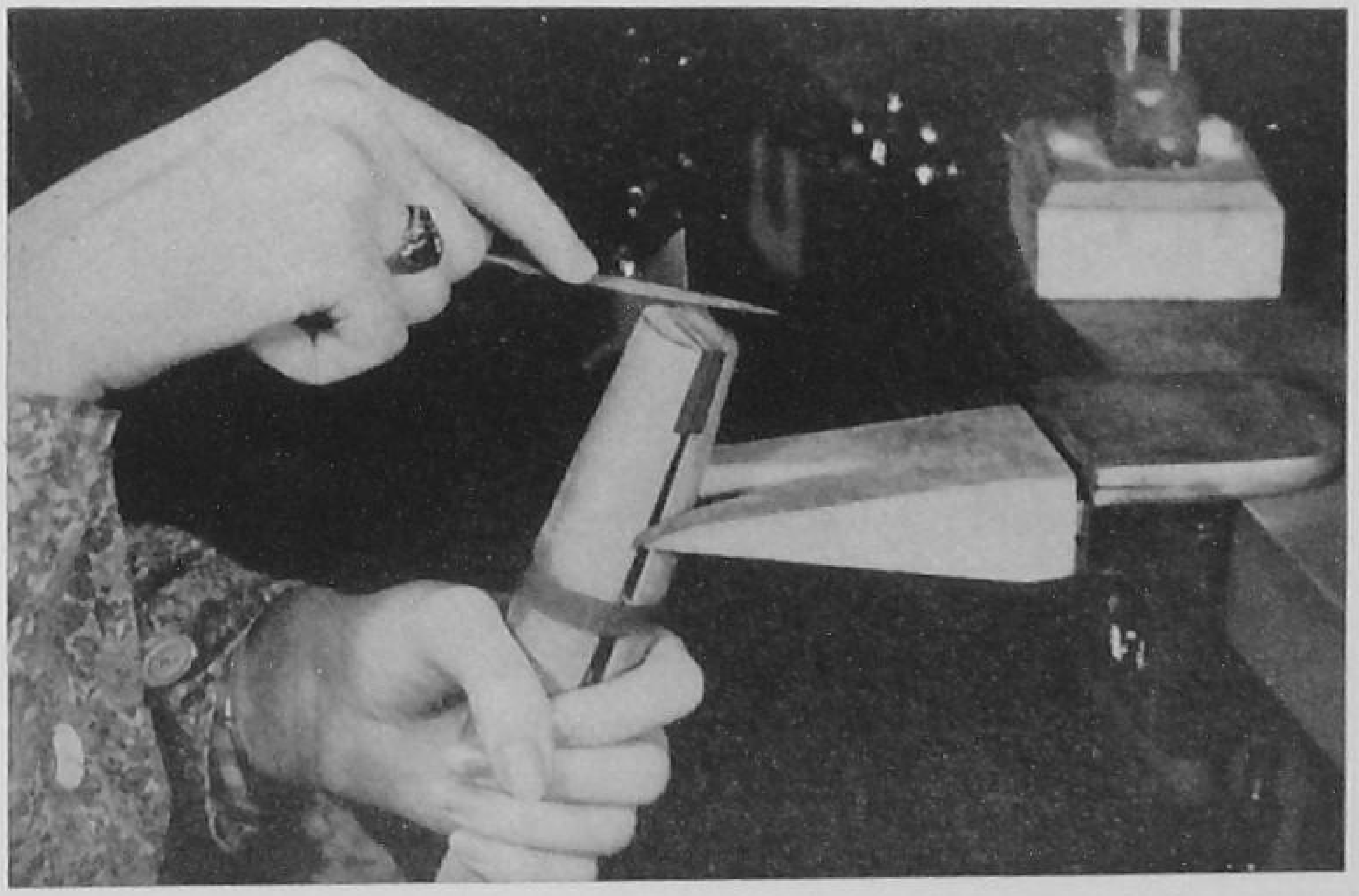


FIG. 11. One method of holding work for filing.

accomplishes very little cutting and quickly dulls the file. The work may be held in the hand, in a ring clamp (Fig. 11), or in a hand vise, depending on the nature of the job. Sometimes the work is mounted in a bench vise. A convenient method of filing small work is to rest the work on the V block and file downward, removing the pressure on the upward, return stroke (see Fig. 12).

Chalk, rubbed lightly into a file, reduces the tendency of the file to fill with metal particles. It also makes it easy to remove the particles with a

file card or a stiff brush for fine-cut files. Do not oil files. Oil may be removed from a file by washing it with Benzine (*beware of fire*). Files have a tendency to fill most rapidly when used on copper, lead, or similar metals. It is unwise to use your choice files on lead if they are generally used on sterling silver. Remember that minute particles of lead on a silver surface will pit the surface when the silver is heated to a red heat.

FIG. 12. Another method of supporting work for filing.

If a file is in particularly bad shape due to filling in with soft particles, it may be redeemed, when a file card fails, as follows:

Take a piece of No. 18 brass or copper about 3/8″ x 1″ and rub the 3/8″ edge slowly and hard against the file, near the tang. Rub it in the *same direction* as the slanting cuts on the file. In a short time, the copper edge will be so shaped as to be a reverse pattern of the tooth cuts. This prepared metal edge, rubbed on any filled portion of that file *in the same slanting stroke,* will remove stubborn particles that previously yielded *to no other method.*

When a borax flux has been used on a soldering job, pickle the work before filing, as the hard borax glaze which remains after soldering is difficult to cut and may dull the file.

If the portion of an article being filed is wider than the file, move the file in such a way so that it travels not only forward, to cut, but also sideways to some extent. This will prevent the cutting of a notch in the work equal to the width of the file.

As with the jeweler's saw, a file can remove only a certain amount of material. Additional pressure may break the file, which, though hard, is very brittle. A coarse file may be used to remove large quantities of metal, but a finer file must be used to finish up the job.

A last note on files: Keep them separate from each other and from other steel tools—rubbing them together will dull their sharp but brittle teeth very quickly.

The "Scotch Stone."

After a file has been used on the surface of a piece of work (but not the edge), it may be necessary to remove the faint marks left by the file. These marks become very noticeable when the work has been buffed or polished. To remove such marks and other marks made by scrapers and other tools, the Scotch stone, or water-of-Ayr stone is used. This is a slate-like material available cheaply in stick form, 6″ in length and in cross-section sizes from 1/8″ x 1/8″ to 1/2″ square. The stone is rubbed against the work, or in angles formed by the juncture of a bezel and a surface, or around applied ornaments. The stone must be kept well moistened with water while in use. It will wear itself quickly to fit the particular shape against which it is worked. If marks are particularly deep, small carborundum sticks may be used before the Scotch stone to hasten the work. The Scotch stone is not intended for use on large areas, in which case one of the many abrasive cloths or papers may be used, but only on small, scratched, hard-to-reach areas, where the application of other abrasive materials is impracticable.

Abrasive Cloths and Papers.

When a piece of metal is selected for use in making an article, it is generally cleaned with a piece of fine steel wool. This removes dirt from the surface, but does *not* clear away marks or imperfections in the metallic surface. For the removal of these imperfections, prior to working the article or polishing its surface, abrasive cloths and papers are used.

Emery cloth or paper is used for smoothing metal. The cloth sheets are usually 9″ x 11″, and consist of emery grains coated on a blue jean cloth.

The grit range for metal finishing runs from No. 3, which is coarse, to No. 3/0, fine.

The sheet may easily be torn to smaller-size squares or strips. To remove scratches, a grit size is selected capable of removing the particular flaw in the metal, and successively finer grits applied, until the surface is quite clear and polished.

Emery polishing paper comes in a sheet size measuring 9″ x 13¾″. The grit range differs from emery cloth and the numbers run from No. 3 to No. 4/0. This paper imparts a very fine surface to a piece of metal, when the finest grit size is used.

A faster cutting abrasive that is available on cloth is aluminum oxide. A well-known make is known as "lightning metalite." This material is available in sheet form or in narrow rolls, in which form it is very economical for hand jewelry work. This product, available on lightweight cloth referred to as "J" weight, runs in grit range from No. 80 to No. 180, with two very fine grits, No. 240 and No. 320.

Crocus cloth and rouge paper are two other abrasive sheets used. Both have a reddish-appearing abrasive surface and are extremely fine in grit size, enabling these abrasives to be used for final finish purposes—final as far as hand abrasives are concerned. The buffing or polishing machine is the next step.

Chapter IV

SOFT-SOLDERING

Soft-soldering is the process of joining two metals by the use of a third metal known as "soft solder." This metal is an alloy generally composed of 50 per cent tin and 50 per cent lead. The metal is sometimes known as "half and half" solder, and is available in wire, ribbon, or bar form. Some forms of wire solder are hollow, or tubular, and contain a flux in the core. Fluxes are generally of the rosin or acid types. The melting point of soft solder is approximately 370° F.

Because of the low melting point, soft soldering has several important applications. It may be used extensively in repair work, particularly of moderate-priced or cheap jewelry, or it may be used in repair work on enameled jewelry. Where repairs are to be made on work containing stones, soft solder may be used when it is impracticable to remove the stones. Where the high temperatures necessary for hard-soldering are not available—for example, in camps or other locations where gas or compressed air is not available—soft-soldering may be done by electric soldering irons, alcohol burners, or gasoline torches.

Soft-soldering, however, is not used on high-class jewelry. Wherever possible, particularly when working with silver and other precious metals, hard-soldering should be used. Soft-soldering, properly understood, may be accomplished easily by young children who are attempting the easier types of copper jewelry.

The same general rules apply to all types of soldering—hard or soft—and they are as follows:

1. The work or surfaces to be joined must be perfectly clean. This may be accomplished by means of a scraper or clean steel wool. Very dirty work may be previously pickled.

2. The surfaces to be soldered must be protected against oxidation by means of a flux—in jewelry work (soft-soldered) a rosin-base flux in paste form is recommended.

3. The work being soldered must be brought to the degree of tempera-

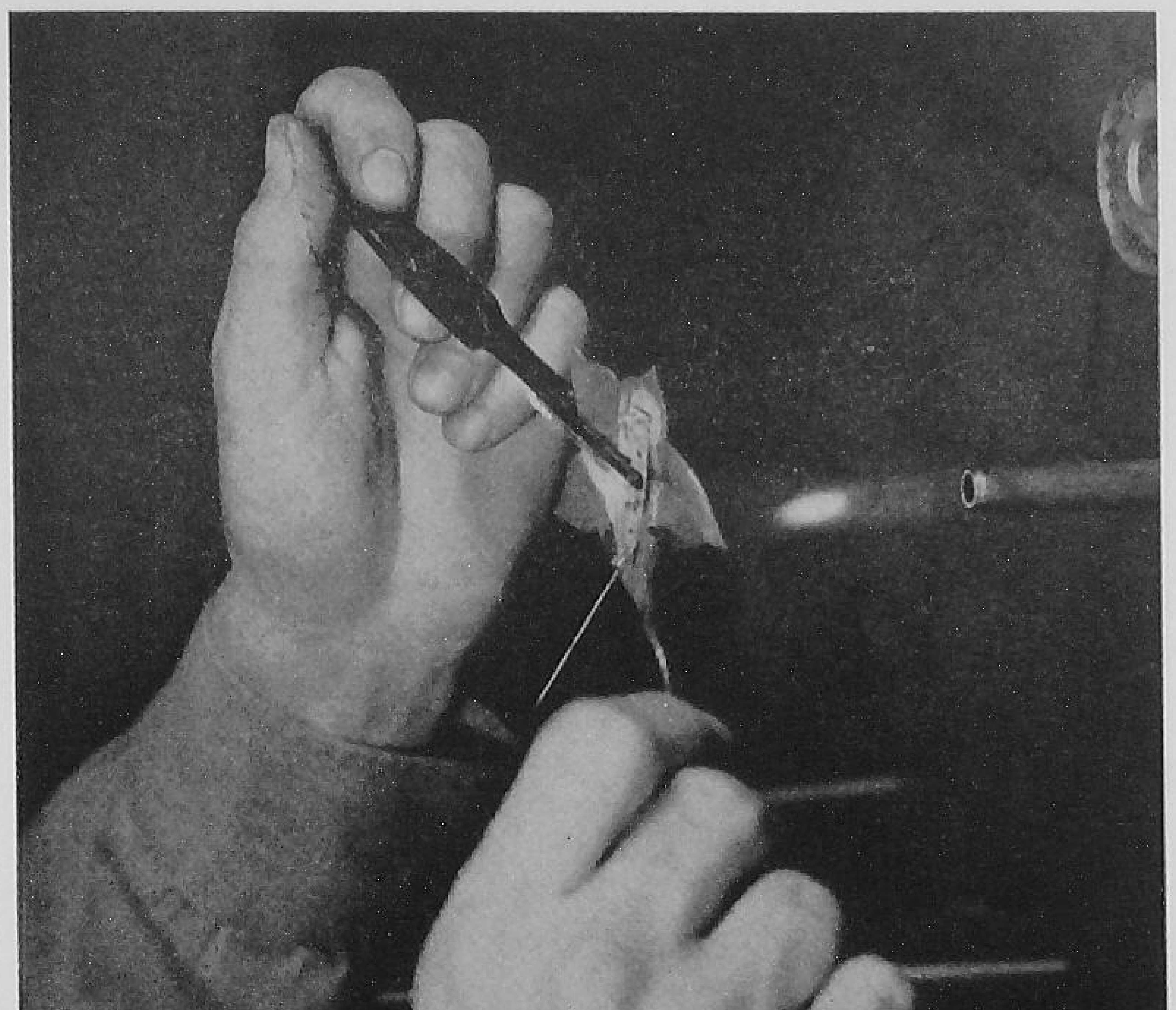


FIG. 13. Soft-soldering a pin-back.

ture necessary to melt the solder. Solder will not adhere to a cool surface, even though the solder is in a molten state.

4. Contact between the two surfaces being soldered must be good. Solder will not flow into a wide gap.

Soldering Pin-Backs.

In Fig. 13 may be seen the method used to apply a pin-back. Where available, a gas Bunsen burner or alcohol lamp will do the best job. Note the locking-type tweezers. This is a convenience of particular importance for young people who are likely to relieve the pressure on the tweezers or soldering tongs before the solder has become sufficiently solidified.

To do this job, clean the back of the brooch thoroughly. The bar on the pin-back should be bent to make good contact with the brooch, at least at either end. The back of the pin-back should be cleaned. Both surfaces should be coated with a *thin* smear of rosin paste flux. The two pieces of metal are held in position with the tweezers so that good contact is established, and then held over a purplish-blue flame. Solder in wire form is held in readiness and is occasionally touched to the work to ascertain whether the work is hot enough to melt the solder. The solder should melt before the flux begins to carbonize or turn dark brown. The solder is applied very sparingly to the edge of the joint between brooch and pin-back. If the contact between the two is good, solder will flow quickly underneath the joint, by capillary action, and an excellent job will result with a minimum of solder showing. When this is accomplished, remove the brooch from the heat and allow to cool.

Note: Care should be taken to avoid the presence of flux or solder in the joints of the pin-backs.

Cooling may be hastened by resting the work on a cool metal surface. The heat will be drawn out of the work more quickly in this way. Do not chill the work by dipping into water. A chilled joint has a tendency to part easily because of crystallization of the solder.

Sweat-Soldering.

Sweat-soldering may be done on soft-soldering jobs as well as on hard soldering. The "rooster" pin shown in Fig. 17B has been sweat-soldered. If soft solder is to be used, coat the upper pieces of the work with solder at the points of juncture. This may be done with a soldering iron or with a small gas or alcohol burner. Clean the work, coat with flux, and hold over the flame until a little solder melts over the proper area. Then clean the

main portion of the work, to which the previously prepared pieces are to be joined, and coat thinly with flux. Now apply the solder-coated pieces in position over the flux-coated piece which has been prepared to receive them. The work may then be heated with a flame while it rests on a large asbestos pad. The pieces will flatten out as soon as the solder underneath each piece melts. If the pieces are so designed that they will not lie properly without some form of pressure, use locking tweezers or cotter pins at each point of juncture (see Fig. 17*A*). When the solder melts, the tweezers will press the parts together and hold them firmly until cool. Remember that the heat of a Bunsen flame is all that is needed.

Using the Soldering Iron.

While the soldering iron is not as handy as a Bunsen flame for doing the work previously described, it is frequently valuable in doing repairs on finished pins. Prepare the "iron" for use by coating its tip with a thin, bright layer of solder. The tip is made of solid copper and must be made bright before "tinning" with solder. The following procedure is suggested. Secure a small, bright square of tin plate. Place a small amount of rosin paste flux in the center of the tin plate, which should be on an asbestos pad. In the flux, place a small piece of soft solder. The brightened, hot tip will later make contact with this flux and solder.

The tip of the "iron" must be made bright before tinning. It must also be hot enough to melt solder when bright, so the tinning should be done rapidly. Heat the "iron" sufficiently, file a bright face on the tip, and bring the brightened face in contact with the solder, flux, and tin-plate. When the tip of the "iron" is removed, it will be coated with solder. A small wiping cloth may be used to keep the tinned surface bright. It is sometimes undesirable to use a file on the copper tip, as this necessitates occasional replacement. A solution to brighten the tip may replace the file. Prepare this solution by mashing a 1″ cube of sal ammoniac and adding it to a glassful of water. Stir well. Keep in an earthenware container. Dip the *hot* iron in this. When bright, apply to tin plate as previously described. This tinned surface will pick up small amounts of solder. The solder may be applied where necessary but it must be remembered that the *work* must also be hot enough to melt the solder. Therefore, hold the iron in contact with the joint *until* it is obvious that the solder between the soldering iron and the work is completely "liquid." Remember also that a small iron will solder small work and may not suffice for large pieces of metalware. An

electric iron of 60 to 100 watts, with a fairly narrow tip, will do very nicely for hand jewelry repairs.

Repairing "White-Metal" Jewelry.

Much popular-priced rhinestone jewelry is made of a tin-alloy metal. These metals are of the pewter or Brittania metal type. The metal has a bright silvery appearance, but, in contrast to sterling silver, it melts at a low point from 425 to 450° F. The metal is easily identified by testing with a pocket knife. It is easily cut or dented. These metals are largely tin—as high a content as 90 per cent. Good grades contain no lead. Other metals in the alloy are small quantities of copper and antimony. The copper makes the metal ductile and is generally present in amounts up to 1.5 per cent. The antimony adds hardness and tends to make the metal expand slightly on cooling. This is desirable in cast products for finer detail. The antimony also adds whiteness to the metal. About 7 or 8 per cent of this metal is used in the Brittania alloy.

To solder pin-backs to such a low-melting-point metal requires care. A rosin paste flux will serve. A small-pointed electric soldering iron, well tinned, may be employed, applying the usual 50-50 solder. Watch carefully, however, for signs of the melting of the Brittania metal, as this will take place soon after the soft solder is brought into contact with it.

Damaged pins of this metal may be carefully restored by building up with solder, using the electric iron. The solder, however, should be lacquered if in a visible location, as it will dull on exposure to air.

Pin-backs are sometimes attached with various cellulose cements. This is highly undesirable and not at all workmanlike. It is a means of saving time and labor on cheap work. If this method has been employed on a pin which is to be repaired, remove all signs of the cellulose cement with a small scraper or knife blade before applying any heat to the work.

Bismuth Solder.

When a solder of a particularly low melting point is needed, "bismuth" solder may be used. This alloy consists of lead, tin, and bismuth. It will melt at less than 300° F. A rosin flux in paste form may be used. If a pewter pin (or Brittania) is being repaired, another flux of value may be made by adding ten drops of hydrochloric acid to an ounce of glycerin. Bismuth solder is available at large craft, hardware, or jewelry supply establishments.

Chapter V

HARD-SOLDERING

The Solder.

In all high-grade jewelry work, when several pieces of metal are to be permanently joined, hard-soldering is used. Hard solder consists of a piece of the same metal used in making the piece of jewelry alloyed with a base metal, such as zinc or brass. The amount of alloy in the hard solder will determine its melting point.

Sterling silver, which is 925 parts silver and 75 parts copper, becomes liquid, or flows, at 1640° F.* Therefore, an alloy of silver must be used as a solder, which will flow at a temperature *safely below 1640°*. Several alloys are available, each melting at a particular temperature. William Dixon, for example, stocks hard solders melting at four different degrees of temperature. The usual range of melting points for hard solders is from 1200° to about 1450° F. Handy and Harman, dealers in precious metals, produce four grades of silver solder for jewelry work, in addition to many varieties of solders for various purposes. The four grades are: "Easy," melting at 1325° F.; "Medium," 1390° F.; "Hard No. 1," 1425° F.; and "Hard," 1450° F. The last is recommended for enameling work.

The purpose of using a variety of such solders is to permit a piece of jewelry to be built up in several soldering operations. Thus, by using a higher-temperature alloy on the first soldering operation and lower-temperature solders on subsequent operations, the danger of melting the solder used on the first operation is lessened. The writer, however, has relied upon the use of protective substances, such as yellow ochre or loam, on previous joints and has had complete success using one grade of solder. Solder is available in wire form, sheet form, or cut form. In cut form, it is supplied as tiny squares (about 1/16"). These may oxidize, however, when stored and are difficult to clean. Wire form is of particular value in link soldering, which will be discussed in soldering techniques. For all-around use, sheet form is preferable, and it is cut as needed, in 1/16"

* Coin silver is 900 parts silver, 100 parts copper. Foreign silver varies in content and is as low as 700/1000. "German silver," or nickel silver, contains no silver; it is an alloy of nickel, copper and zinc.

squares, as shown in Fig. 14. The sheet of solder is cleaned first with clean steel wool.

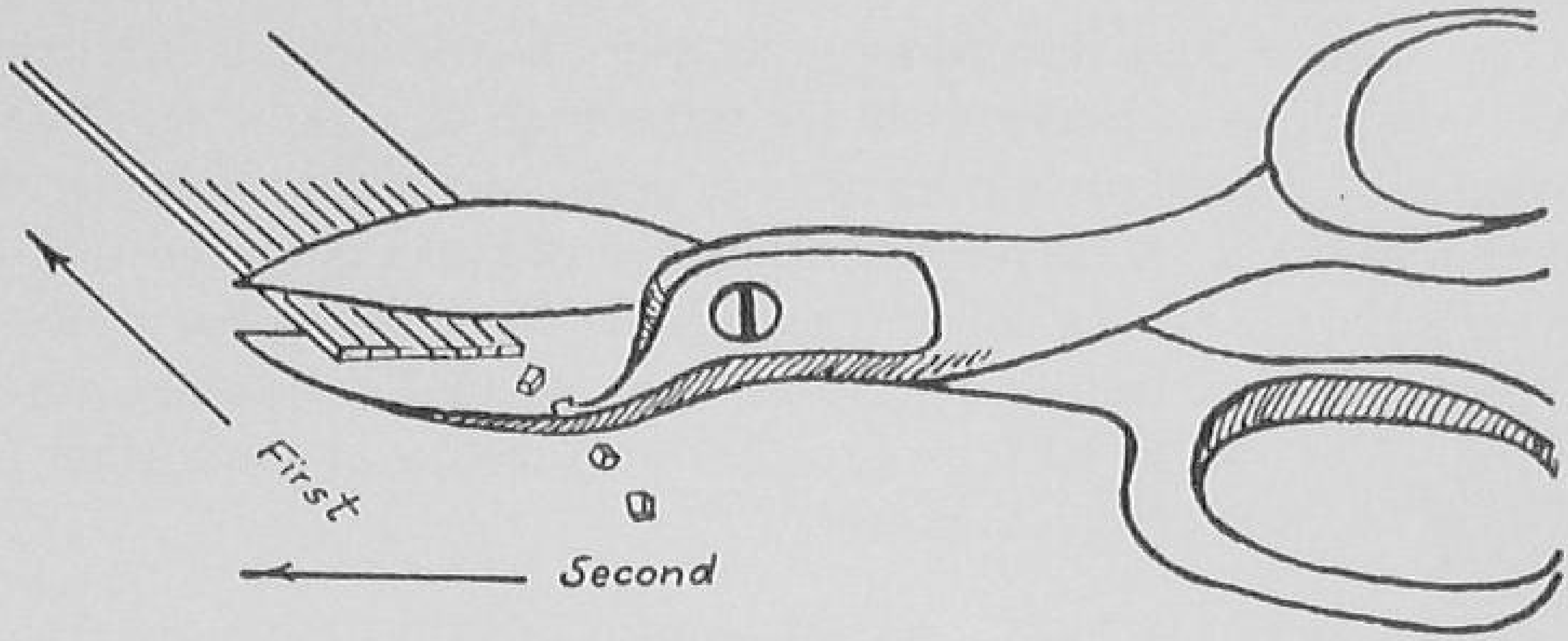


Fig. 14.

The Flux.

In the heating of a metal, an oxide is rapidly formed, and this oxide prevents solder from flowing over the metals being joined, thus preventing their union. Therefore, a substance known as a *flux* (derived from the Latin, meaning "to flow") is used. The flux, coated over a previously cleaned surface, will not prevent the flow of the solder or its contact with the metals being joined, but flux will prevent a metallic oxide from forming, absorb oxides formed in preheating, and help solder to flow. The flux itself must form a protective film before the melting point of the solder is reached, and must not be rendered useless by excessive temperatures. This means that fluxes especially prepared for hard-soldering must be used.

The flux most widely in use is common borax. Mixed with water, it obtains the consistency of cream. It is prepared by rubbing a piece of borax, in stick or lump form, in a borax slate into which a small amount of water has previously been poured. The flux is ready when the mixture takes on the consistency mentioned. Sometimes borax is used mixed with boric acid. These mixtures range from 75 per cent borax and 25 per cent boric acid to 75 per cent boric acid and 25 per cent borax. In general, the addition of boric acid raises the point at which the flux becomes fluid. Borax flux becomes fluid at about 1400° F. Other fluxes, prepared for hard soldering, become fluid at different points, generally lower, and this is a fact to remember when working on jobs requiring a number of soldering operations. Also remember that the point at which the flux flows does not affect the point at which the solder flows. Borum junk is also used as a flux, and is a good one. It is prepared and used in a similar manner to borax. The

writer has found liquid *commercially prepared* fluxes particularly suitable for those who have only moderate experience in hard soldering for the following reasons:

When common borax is used as a flux, the water in the mixture tends to displace the pieces of solder when the water boils in preheating. This can be avoided by careful preheating so as to gently evaporate the water, leaving a film of borax. However, when this film of borax is heated to form a protective glaze it "blows up" into a froth-like form, lifting the solder with it. When continued heating melts the borax, so that it subsides, together with the solder, the solder is frequently found resting at some other place than that which it occupied originally.

Techniques

A variety of techniques is used in hard-soldering, each technique having a particular value in a specific case. General rules, however, are the same in all cases and are dealt with at this point before going into specific cases.

The first step to remember in hard-soldering is that all parts involved in soldering must be *clean;* free of dirt, grease, oxides, and other foreign materials. Cleaning can be accomplished by various methods, depending on the condition of the metal. Badly oxidized pieces are cleaned first by heating in an acid pickling solution. (See *Pickling.*) Such pieces are then rinsed in cold water. Work may be scraped with a scraper at the point where soldering is to be done, cleaned with a small, clean file, or rubbed with clean steel wool. Any residue from the steel wool should be blown away before applying the solder and flux. Soldering is impossible unless work is perfectly clean at the area being soldered.

Fitting: Hard solder *will not* bridge a gap between two pieces of metal, so the work must be fitted perfectly. Seams must be snug, and all junctions of any nature must be perfectly fitted if it is intended that solder flow into these junctions. In soldering, a phenomenon known as capillary action takes place. This means that the solder, when reaching liquid state, will flow readily between two tight-fitting surfaces, joining them securely, whereas an imperfect union will result if the fitting is uneven. This point cannot be overemphasized. Solder will not hide the mistakes of poor fitting. It will refuse to flow into a gap. When such a gap exists in a job and it is impractical to make a part over, fit the edge of a small piece of the same metal as that being worked upon into the gap so that it fills the gap properly, and solder into place. File the excess metal away after the soldering has been completed.

Applying Flux and Solder.

The flux is applied with a camel's hair brush to the *freshly* cleaned surfaces, and then the solder is applied, using the flux-dampened tip of the brush to pick up the small pieces of solder. Flux also covers the solder. Experience will aid in determining the amounts to use, but, in general, one should try to roughly estimate the amount of solder required to flow between the surfaces being joined. If, during a soldering operation, it has been found that insufficient solder has been used, the tang of an old needle file dipped in flux may be used to convey additional pieces of solder to the work being soldered. During this time, the flame is momentarily removed.

The Heat.

To heat the work, in soldering, a source of heat is used which is able to bring the work up to the proper temperature. In very small work, a mouth blowpipe may be used together with a Bunsen burner or an alcohol lamp. The use of such a blowpipe requires practice. To solder the joint on a small bezel or wire ring, a Bunsen burner alone will give sufficient heat, and the beginner will be less likely to melt the entire bezel.

Proper heating requires judgment, and several points to remember are given here: Some indication of the temperature can be had by observing the glow emitted by the work being soldered. This is made easier by shielding the work from any direct light. The first visible red will then occur at about 900° F. At about 1200° this will turn to an even, dull red. Bright or cherry red appears at about 1400°, and a pink appearance—the danger point—at 1600° F.

Before attempting to melt the solder, the work should be preheated. If using a gas and air torch, use a moderate flame and move it slowly over the entire surface of the work. When the work is dull red, begin to concentrate on the joint. Remember this: Solder flows to the *hottest point*. Therefore, finally concentrate the heat *on the joint* and allow *the metal of the work to melt the solder*. If the soldered joint occupies a small place on a large mass of metal, heat the whole mass first before attempting to solder the joint. Melting the solder first will cause it to assume a ball-like shape and when this happens, it will not flow out until the main body of the work reaches the temperature required to melt the solder. Melting solder first will frequently cause a pitting of the surface at the joint. Other causes of pitting are dirt and the presence of small quantities of lead, generally due to using files previously used on lead, or residue from lead

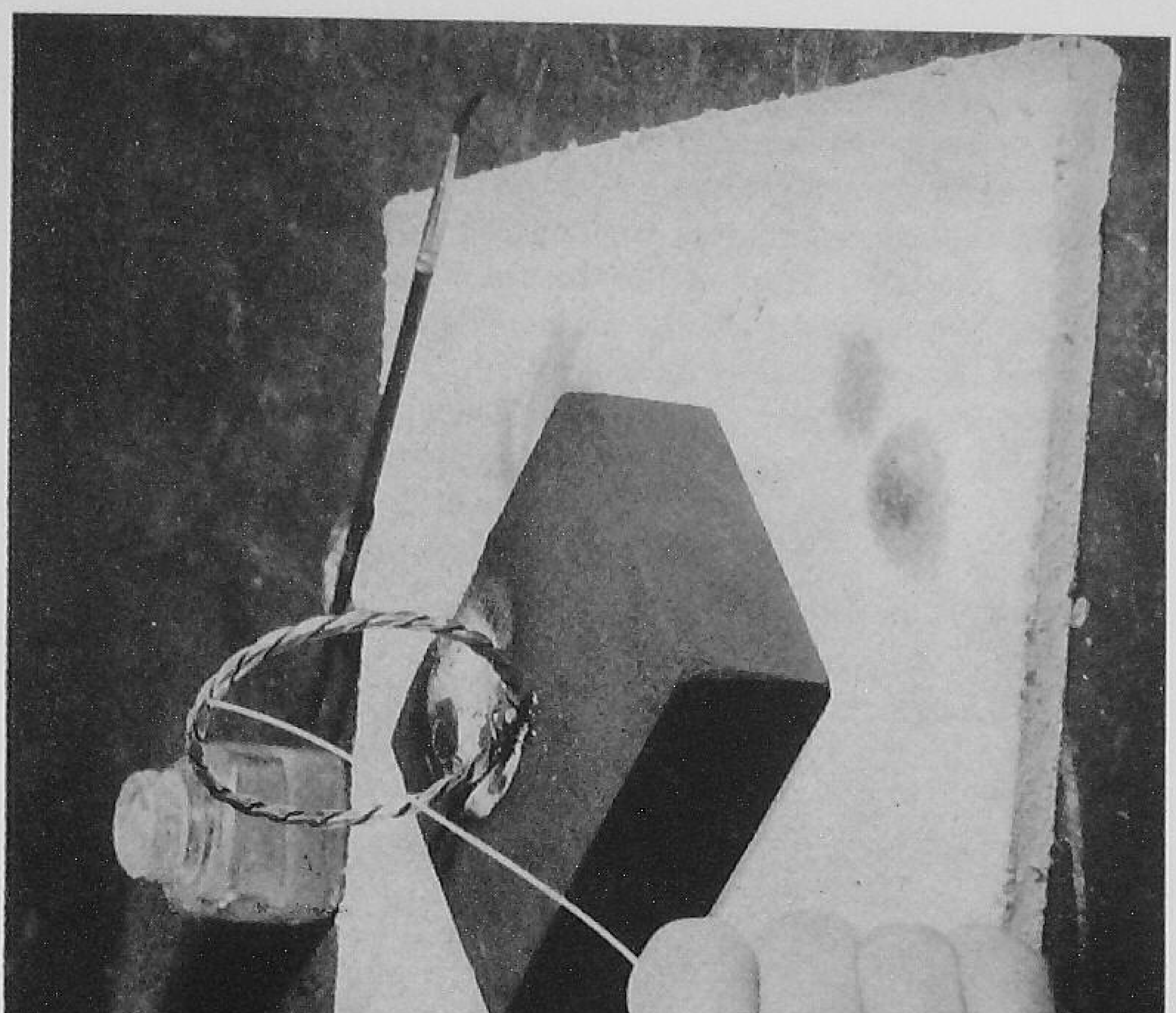


FIG. 15. Joining the ends of a bangle using wire solder (hard). (*Torch, Courtesy of Dresco Dental Supply Co., Brooklyn, N. Y.*)

blocks upon which the work was shaped. When solder persistently "balls," either the heating methods are incorrect, the fluxing is insufficient, or dirt of some type is present. Drafts of air sometimes delay heating when work is done near an open window.

When using the gas and air torch, remember to have the gas and air tubes connected to their proper terminals—they are not interchangeable. Avoid a "roaring" blue flame. A "roaring" noise and a bright blue cone at the base of the flame will indicate too much air. Such a flame may cool work faster than it may heat. Subdue it by reducing the air intake. The greatest heat is generally near the point of the flame. Never allow yellow to appear in the flame—a purplish color is about best. There should be some relationship between the size of the flame and the size or mass of the work, so observe this point carefully.

A torch is available that requires *no* compressed air supply and gives a flame satisfactory for hard-soldering. This torch operates on ordinary illuminating gas and provides sufficient heat for good work on rings and brooches of moderate size. In Fig. 15, it is shown in use while the ends of a bangle bracelet are soldered. Wire solder is being used in a technique similar to that used in joining the ends of links for chain making.

Soldering Aids.

In hard-soldering, the work is generally supported on a charcoal block. Additional soldering aids are iron staples, cotter pins, binding wire, nails. With experience, uses for such items will suggest themselves, but a start can be made by remembering these procedures: A "gallows" formed by a piece of heavy wire—No. 16 to No. 14—can be used when working on flat rings or bezels (Fig. 16). Iron binding wire can be used to hold joints tight fitting, although, when it is possible to do without such wire, avoid its use. Solder will sometimes flow along such a wire, leaving ridges. Also, overheating the wire may cause it to burn portions of the work. The binding wire is oxidized to avoid the possibility of solder sticking to it (this

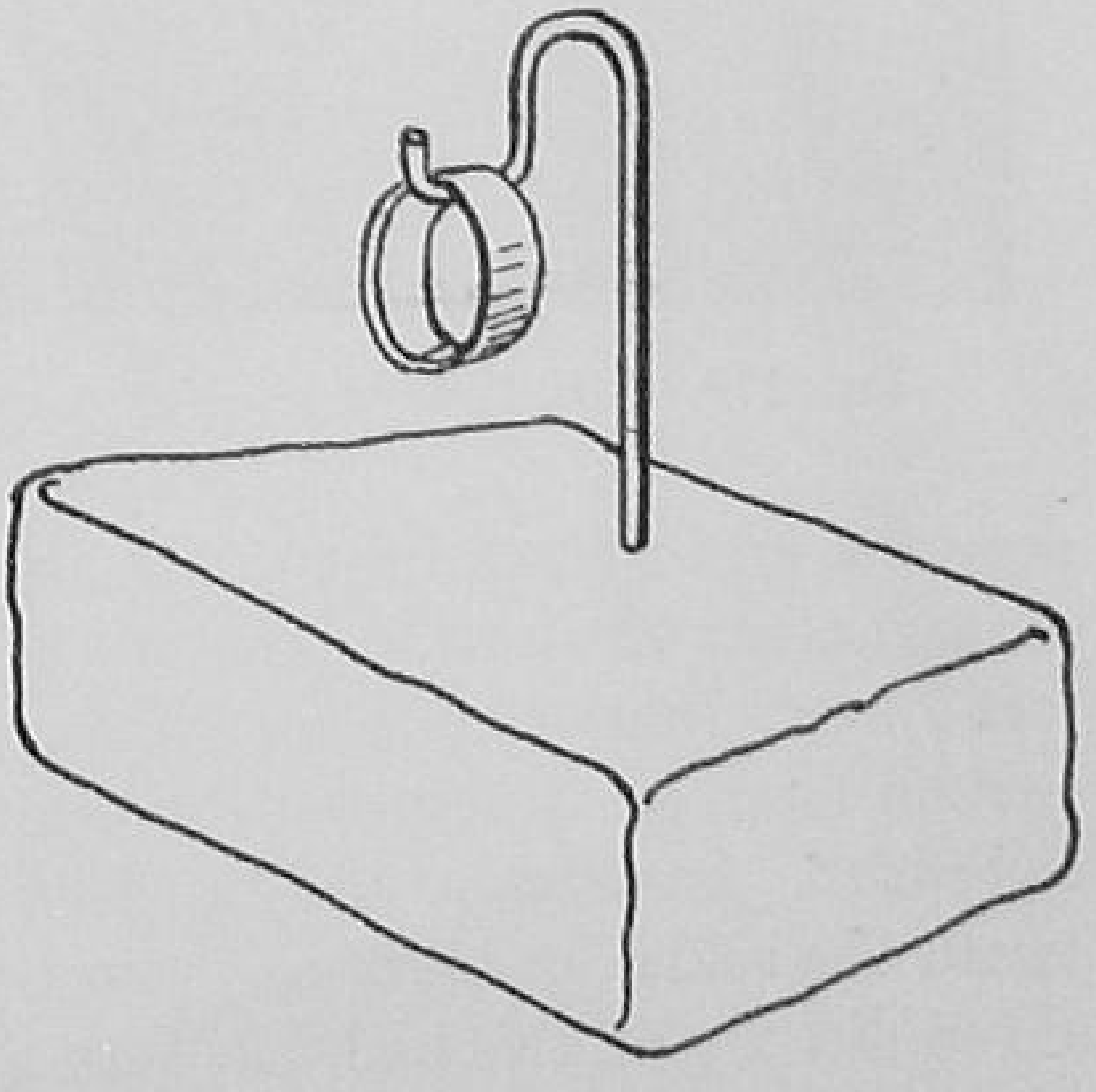


FIG. 16.

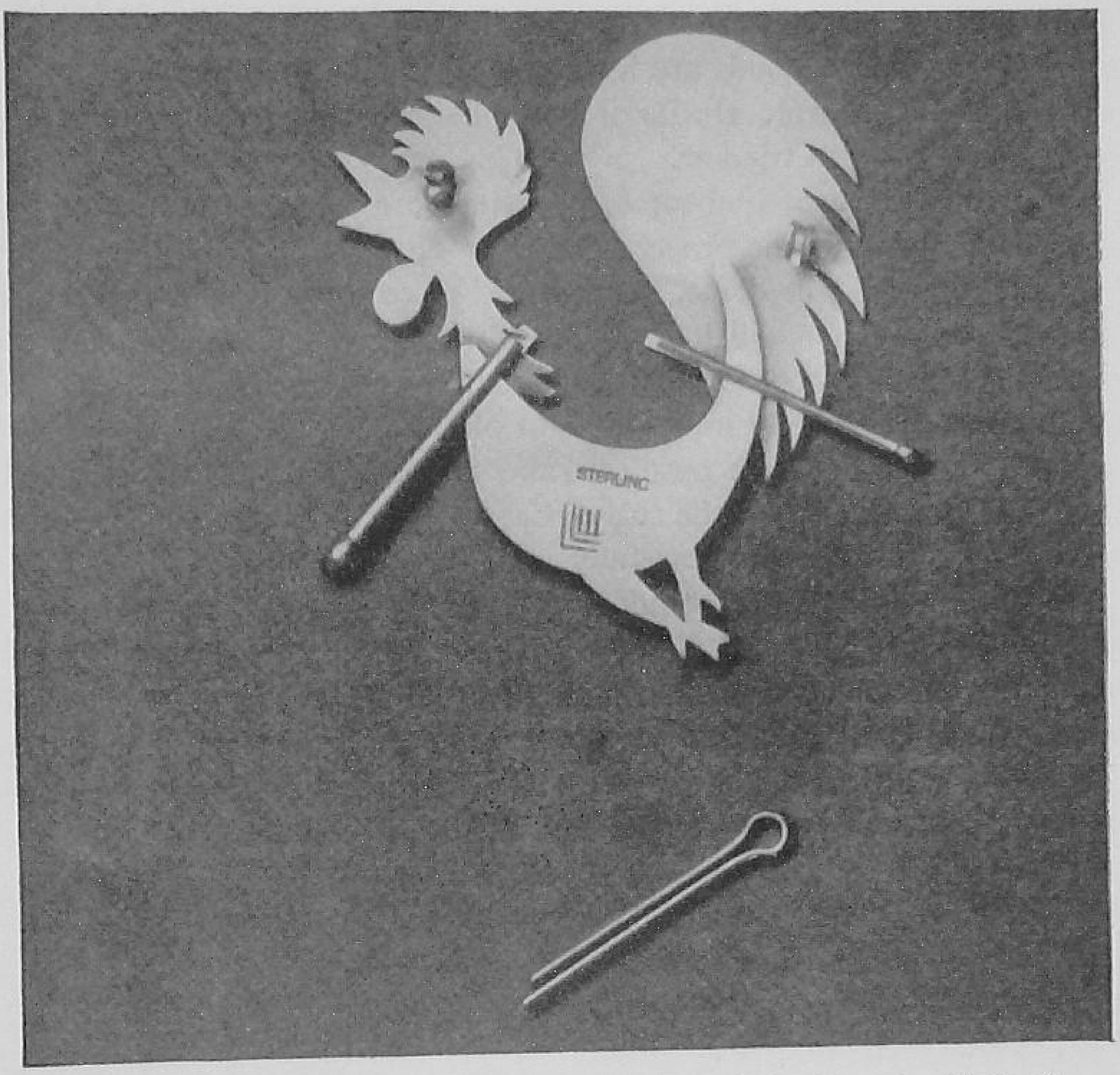


Fig. 17A. A method of securing parts of a job during "sweat-soldering."

accounts for its black color), although solder may sometimes flow over it. A magnesium block may substitute for a charcoal block and will probably last longer. Portions of some pieces of work can be imbedded in the magnesium more easily than on charcoal, affording protection to the portion imbedded. An asbestos pad, at least 12″ x 12″, should be placed underneath the soldering block to protect the bench. Some work may be soldered directly on this pad, but care should be taken to have the pad in a clean condition, with no stray filings or other waste materials on its surface. Staples are valuable when soldering lengths of wire together side by side, as in making ring shanks or bracelets (see Figs. 80 *A* and *B*). Cotter pins act like tiny clamps to hold work closely together during soldering. Fig. 17*A* and *B* show a "rooster" pin assembled by the "sweating" process described in pp. 37-39. The main parts of the rooster are held

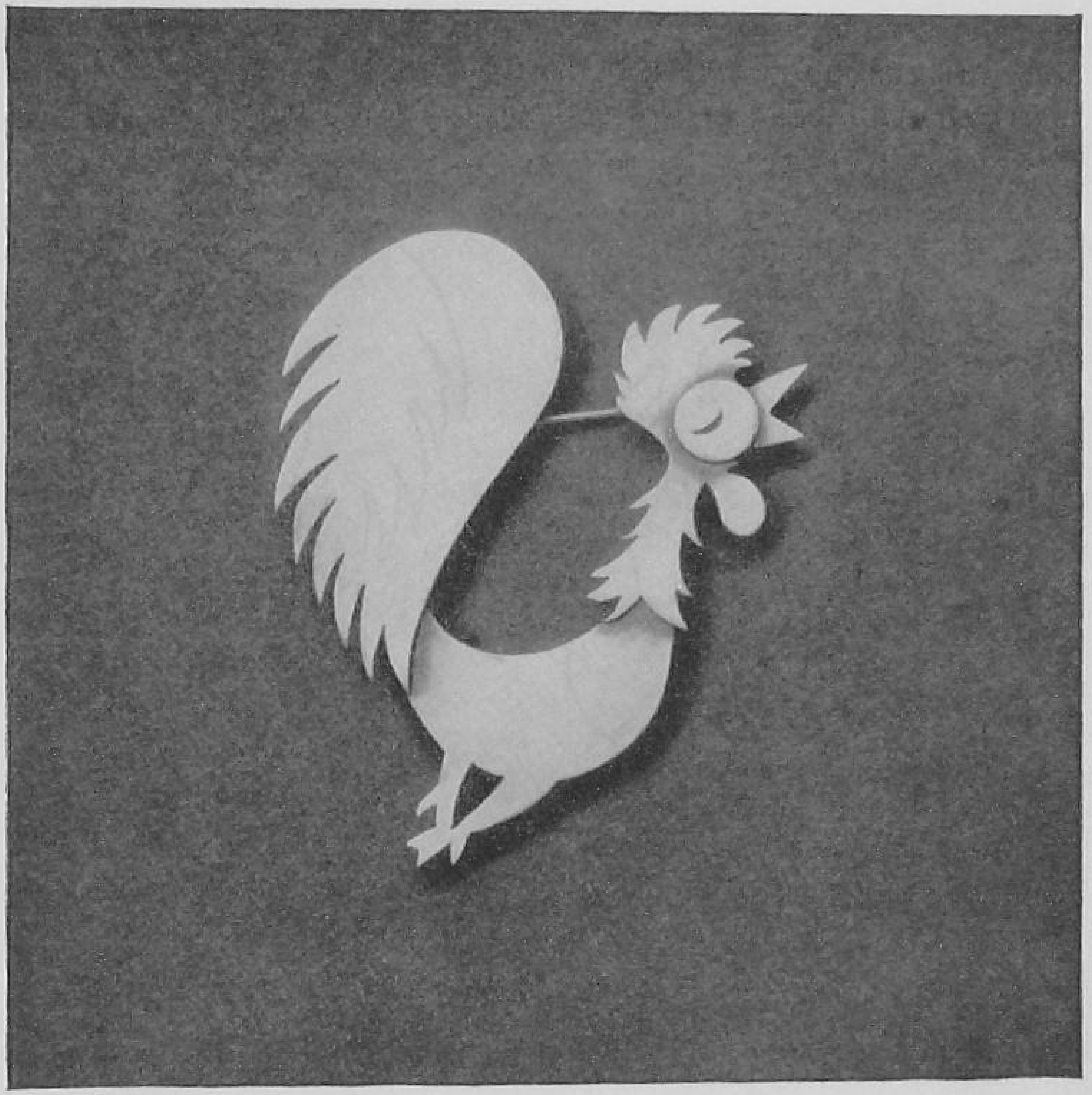


FIG. 17B. The completed rooster pin.

in position with cotter pins during heating. Normally, the joint and catch are applied last. The model in the photo, however, has already been completed. It is being used only to show the application of the cotter pins.

Protection of Stones During Soldering.

Remember that in hard-soldering, either during the fabrication or repair of jewelry, ornaments other than metal—stones for example—will be affected by the heat and should be removed. In some cases where a stone cannot be removed from a ring, the following procedure is frequently successful, although some element of danger will exist with the inexpert: A somewhat oval potato is mounted upright. A tripod may be formed by the insertion of 3 long nails at the base. A slot is cut in the potato and the

stone with its setting is carefully worked into the potato until it is shielded. A broken ring shank may then be hard soldered. Use a small flame and do not dwell upon the operation too long.

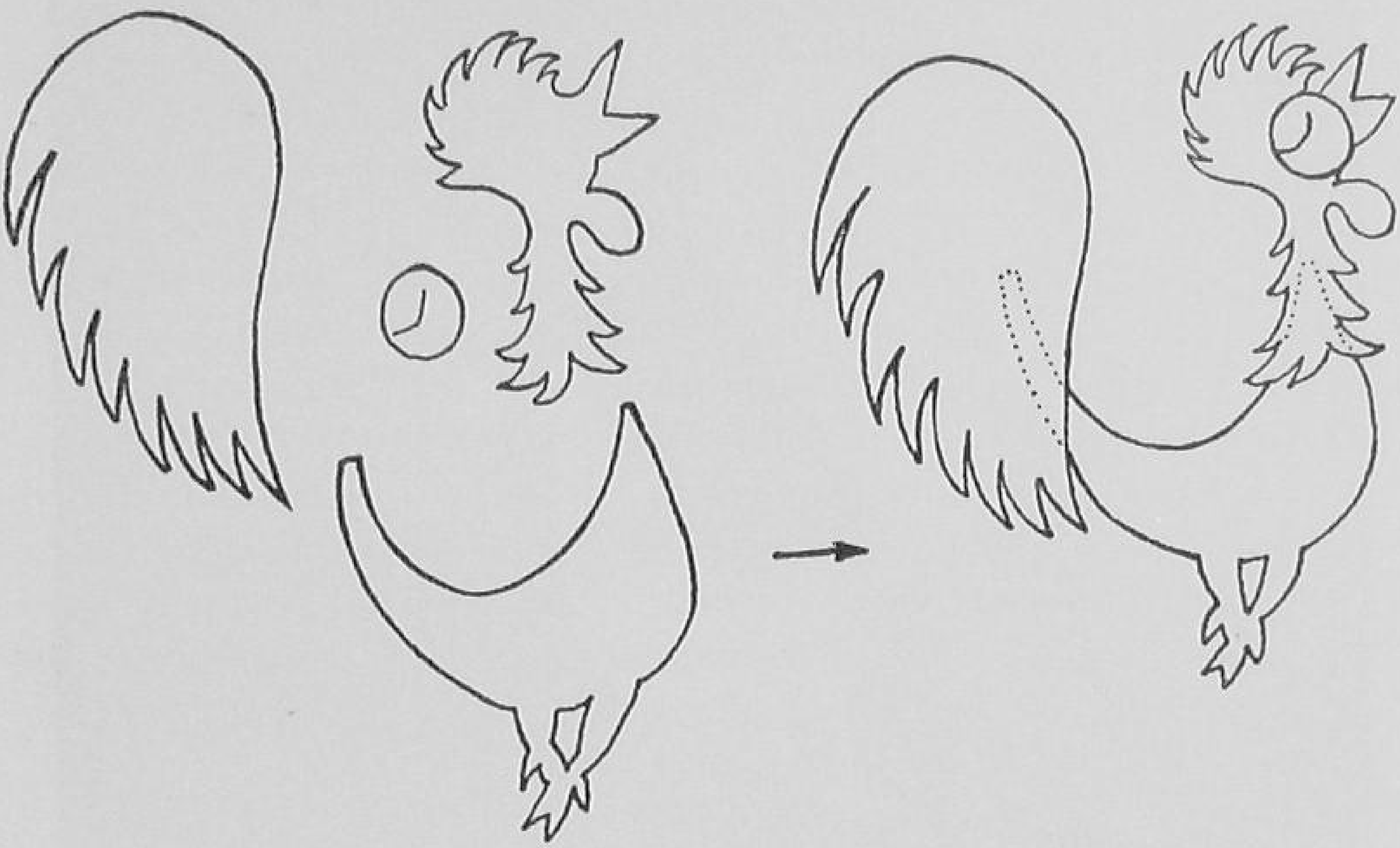


FIG. 18. Full size pattern for "rooster pin."

Soldering Filigree.

When soldering the assembled pieces of coiled wire that compose filigree work, solder is used in a "granular form." This is made by filing solder into a small amount of flux. The combined flux and solder filings are deposited at the junctions of the assembled work with a camel's hair brush and the work then heated in the usual manner. Links are sometimes soldered in this manner.

Multiple Soldering Jobs.

Sometimes different "grades" of solder are used in multiple-soldering jobs. For example, a bezel may be soldered to a piece of silver, then some form of metal ornament, such as a dome, soldered to the work, and, finally, a catch and joint soldered to the reverse side of the work. The procedure in such cases is to do the heavy soldering first, using a solder with a high melting point. If the ornament to be applied to the work is larger in mass than the bezel, it is soldered first. Then the bezel may be done, using a solder with a somewhat lower melting point. If the ornament will not be

dislodged by the melting of the solder used in its application, a similar grade of solder may be used in mounting the bezel. When this work is done, the joint and catch are applied to the reverse side, using a solder with a somewhat lower melting point. During this work, the previous joints have no protection. Sometimes they are coated with a borax flux, which has a tendency to keep the joints together. The differences in melting points of the solders used may be deemed sufficient protection against the disintegration of the work done. For the inexperienced, all previous joints can be coated with a mixture of water and yellow ochre or loam, or a mixture of water and jeweler's rouge in powder form. These substances are used mixed to a mud consistency. They are painted heavily over the finished joints and can usually be relied upon to hold the work together, even though a single grade of solder was used for all work. When substances as ochre, etc., are used for protection, the mixture is slowly heated, after it has been applied to the work, to evaporate all the water and to prevent the flux from the new joint from mingling with the ochre or loam. When all soldering is completed, the loam is cleaned off with hot water and an old toothbrush before pickling. This will keep the acid pickle in a clean condition, usable again for further work.

Using Investments.

A method used by dentists, for protecting built-up bridge-work, involves the use of shredded asbestos fiber and plaster of Paris. This "investment," as it is called, may be utilized by the jeweler for excellent protection of soldered work during heating processes. Shredded asbestos fiber is available at jewelers' supply houses. One part of asbestos fiber is mixed with two parts of plaster of Paris in water. The asbestos eliminates the tendency of the plaster to crack during heating. Complicated pieces of work may be treated with investment and heated as soon as the investment is dry. The compound is applied fairly heavily and may be broken off by chipping with a knife when soldering is completed. Remember that large masses absorb heat, so consider this when judging the preheating of a job treated with investment.

Surface Protection.

Frequent heating of the work sometimes results in a pitting of the surface. Also, in annealing metal, the surface is sometimes adversely affected by the heat. If this is found to be a frequent trouble, a thin solution of boric acid and water may be painted over the exposed surfaces, after which

heating may be done or flux and solder applied, without either harming the metal's surface or affecting the soldering being done. The boric acid solution may be removed with hot water.

Some Specific Hard-Soldering Jobs

To Solder Joint on a Bezel.

Small bezels are frequently made of fine silver, rather than sterling, for two reasons. First, the fine silver is softer and can be easily burnished over the edges of a stone, thus keeping the stone set in its place. Second, the melting point of the fine silver is somewhat higher, and there is less danger of melting the delicate bezel. Because the beginner is liable to melt a bezel during the soldering of the joint, the use of a Bunsen burner will be safer. Otherwise, a very gentle blue flame from the gas and air torch may be used. Some prefer to bind the formed bezel with a light binding wire, such as No. 24, to keep the joint closed. If, however, the two edges of the joint are alternately bent past each other—first one over and past the other and then the reverse procedure—it will be found that the two edges of the joint will tend to spring against each other without the use of the wire. These edges should show *no light* between them. The bezel may be hung from a "gallows" of heavy binding wire, such as shown in Fig. 16, with the joint down. Then put flux and one or two pieces of solder on the seam, depending on the size of the bezel. Pre-heat gently, and then concentrate the flame on the joint. It should solder at red heat. The use of binding wire is usually unnecessary, and its use will introduce the danger of marring the surface of the bezel, should the wire be overheated.

To Solder the Bezel to a Ring or Flat Base.

The bezel must first be trued at its base. This is done by placing a piece of No. 0 emery cloth on a flat steel plate or sheet of plate glass, with the abrasive side up. The bezel is then gently moved to and fro over the emery cloth until a check shows that no light comes between the underside of the bezel and the plate. The surface to which the bezel is to be soldered may be trued in the same manner. Avoid bearing down at any one point. The bezel and the work should then fit perfectly with no need for binding. A flat piece of work is then laid on the charcoal block and the bezel set upon it.

A ring may be set up by pressing the edge of a five cent piece straight

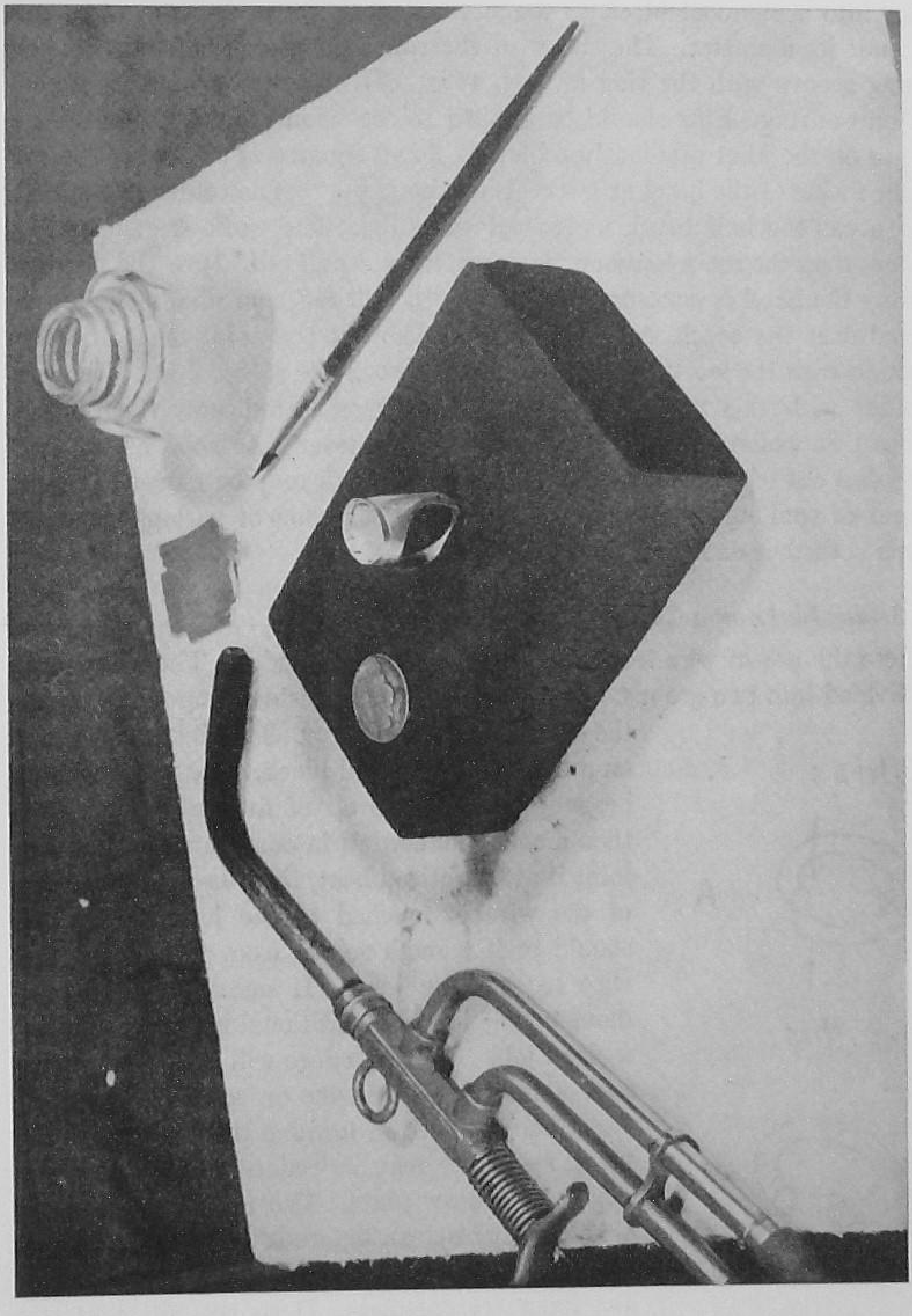


FIG. 19. Bezel ready to be hard-soldered to a cast ring.

down into a charcoal block or magnesium block for a distance of about one half its diameter. The shank of the ring is then worked into the resulting groove with the ring face up (Fig. 19). The bezel is then placed flat on the ring. Flux should be applied to the seam around the bezel, as well as on the joint previously soldered. Small squares of solder are placed on the inside of the bezel at intervals of about $\frac{3}{16}$″. The solder is handled with a camel's hair brush moistened with flux. The work is gently preheated, then the main body or mass heated to a dull red. Now the portion bearing the bezel is concentrated upon until dull red, and finally the flame played over the bezel. A charactertistic gleam at the point of the bezel's junction with the work should be apparent when the solder flows. Become familiar with this "gleam" of molten solder as it indicates the precise moment at which the flame may be safely removed. As soon as the red color dies out of a piece of soldered work, the work may be moved without danger of spoiling the soldered joint. The fashioning of various types of bezels is further discussed under *Stone Setting*.

To Solder Links on a Chain.

Here the use of wire-form hard solder is recommended. The links may be divided into two groups. One group may be set aside temporarily while the other group is soldered. The links are placed on a flat, clean charcoal block. The joints should be snug-fitting. A drop of flux is applied, and then a small, somewhat intense flame. When the joint is at bright-red heat, the flux-moistened end of the wire is touched to the joint. The link should melt enough solder from the end of the wire to seal the joint. If necessary, keep the flame on the joint an additional moment to make a clean job. This procedure will work best if the wire solder is no heavier or somewhat lighter, than the wire used in forming the link. If necessary, the solder may be reduced in diameter by means of a draw plate. Also remember that the solder must be clean before it can be successfully used. Clean with steel wool. Now one half of the links are complete. Open the joints of the remaining links, *not* by springing them away from each other, but by moving the wire ends to the side (Fig. 20). Join a soldered link, an

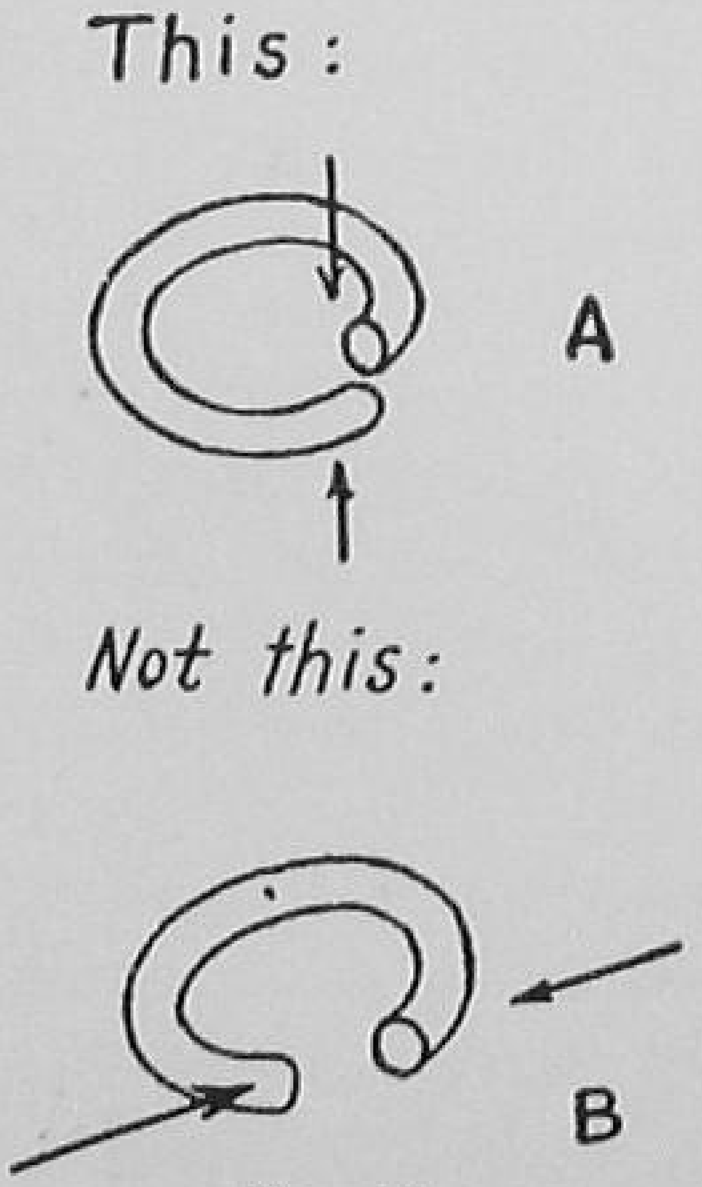


FIG. 20.

open link, a soldered link, etc. Bend the wire links closed again, and repeat the soldering process in a similar manner to the first operation. (See Chapter XIV, p. 147, "Wire-Working"—*Links*.)

Soldering Two Domed Pieces Together.

If two domes of equal diameter are to be soldered together, true their bottom surfaces with surface plate and emery, as previously described, and coat with flux. Now hold the two, properly positioned, with a long soldering tweezers. Heat in the flame of a torch which is secured by vise or clamp, and touch the edges of the seam with wire solder, moistened with flux, when the work has reached red heat. The solder will rapidly flow around the seam, at the proper temperature. When doing such a job, select a soldering tweezers sufficiently strong to hold the work, but not so heavy as to absorb most of the heat. Avoid too much pressure on the domes, as at red heat the work is soft and may be dented.

When two hollow pieces are joined, or a hollow to a flat, the trapped air is expanded and will try to escape at the seam. Sometimes this will result in a persistent pinhole at some part of the seam, where the air escapes. If the presence of a tiny drilled hole (either on the dome which is to be in the rear or on the flat of the work) is of no consequence, then the pinhole difficulty can be done away with by drilling. In joining the two hollowed sections of a heart-shaped locket, a hole is permissible at the top for the insertion of a loop.

When domes as small as $3/16''$ or less are to be mounted on a surface, the procedure is as follows. True the bases of the domes, clean under surface (concave) thoroughly, and coat with flux. Now melt 4 or 5 tiny squares of solder in the cup-shaped hollow of the dome. The amount of solder needed will decrease with the size of the dome. Clean the surface to which the dome is to be applied, drill a tiny hole to correspond with the center of the dome, and coat with flux. Now place the domes in position, over the tiny holes, and heat the large mass of the work on a charcoal block. At dull red heat, concentrate on individual domes and the solder inside will flow down to the closely fitted seam or joint. A gleam at the junction of the two pieces of metal will show when the solder has run around the seam.

Application of Small Ornaments ("Sweating").

If small ornaments, such as leaves, small, shaped pieces of sheet metal, and so forth, are to be soldered to a surface, the procedure is somewhat

similar to the soldering of small domes. To the clean underside of the ornament are applied flux and a few pieces of hard solder. The ornament is heated until the solder has melted over its underside, which at this point is face-up on a charcoal block. The major portion of the work is now cleaned at the point to which the ornament is to be affixed, and flux applied. The ornament is now placed on the work in its normal position and the work heated. Both work and ornament are carefully brought to a dull red together, and then the flame applied at the ornament. The gleam at its base will tell when the solder has "taken hold." Sometimes, slight pressure is applied at this point with a long, thin soldering tweezers to make the junction perfect. This soldering process is commonly called "sweating" work together. The pieces of the rooster pin, Fig. 17*A* and *B* and Fig. 18, have been assembled in this manner.

Soldering on Sloping or Curved Surfaces.

When pieces of jewelry are so shaped that applied ornaments have a tendency to roll off rather than stay in position for soldering, the following is the procedure: Mix gum tragacanth with water to a thin paste-like consistency (see p. 183). This substance can be secured from a chemical supply house. The mixture is applied to the ornaments in just sufficient quantity to secure them in position. The flux and solder may then be applied. Preheat work, from underside if possible, bring to red heat, and concentrate flame on joints. The gum tragacanth will not affect the soldering process adversely. This same mixture, incidentally, is used to keep enamels in place during firing in inverted positions.

Soldering Joints and Catches.

The cleanest and most effective method for soldering a joint and a catch to the back of a brooch may be accomplished as follows:

The position of the pin is established. The novice is advised to mark the path of the pin on the back with a scriber to avoid mounting the catch or joint incorrectly. The position of the pin should be slightly above the center of gravity of the brooch. If the pin is set too low, the brooch will "hang" awkwardly. Remember that a pin may pass over a space in the design of the brooch, as it will not be visible when worn on an article of clothing. Mark a small "x" with the scriber where the catch is to be placed. Make a small vertical line where the joint is to be. The pin itself must not be inserted in the joint until the soldering is done. The point

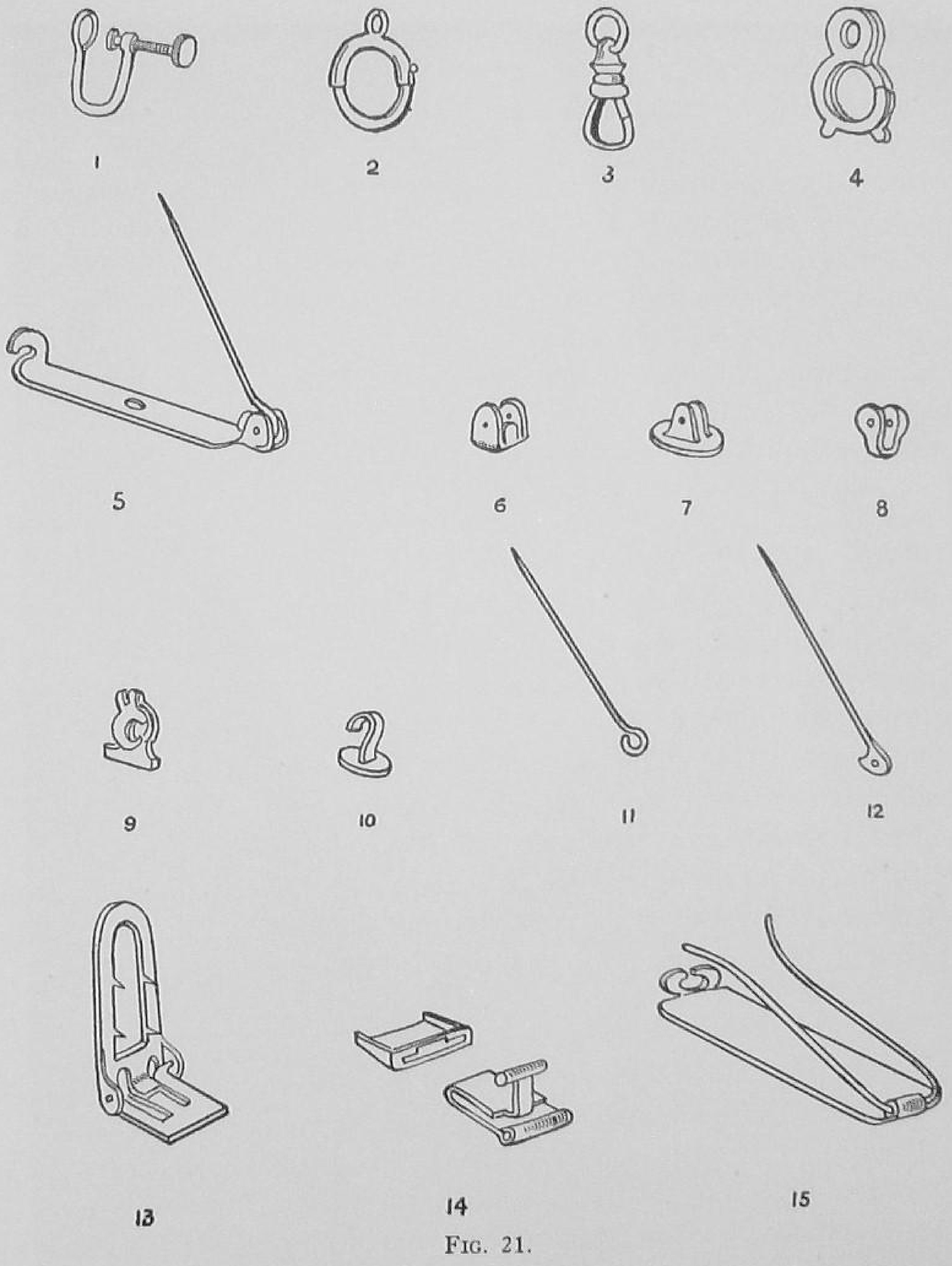


Fig. 21.

SOME COMMON FINDINGS

1. Ear-back, or earwire; 2. Spring ring; 3. Swivel; 4. Sister-hook; 5. Pin-back (also available with safety catch); 6. Joint ("self-riveting"); 7. Joint, patch-type (for soft-soldering); 8. Joint; 9. Safety catch; 10. Catch, patch-type (for soft-soldering); 11. Coil-pin (for self-riveting joint); 12. Pin-tong (used with rivet on No. 8); 13. Clip attachment; 14. Clasp; 15. Barrette attachment.

Note: Better grade findings are made in the precious metals—gold, platinum, etc. Other findings are usually available in brass, nickel-silver, or nickel-plated brass.

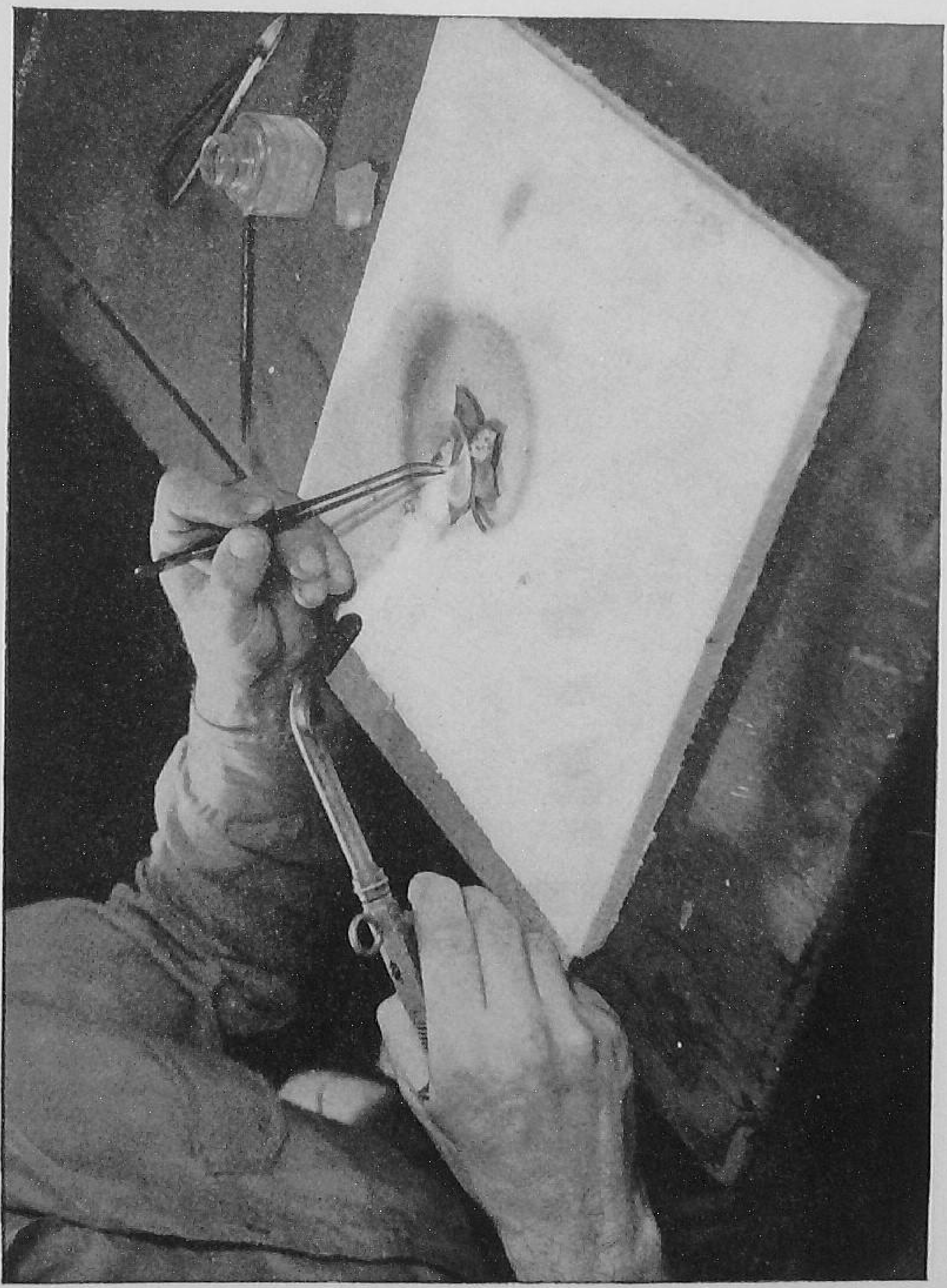


FIG. 22. Applying a catch by hard-soldering.

of the pin should project about ⅛″ to $\frac{3}{16}$″ past the catch, but not past the edge of the brooch.

Next, clean the two places to be occupied by joint and catch. Apply flux and two pieces of solder to each point. Preheat the work, then concentrate on each spot in turn until the solder becomes fluid. Remember that all soldered work on the reverse side should be liberally protected with jeweler's rouge, loam, or ochre. Carefully clean the bottom of the joint and coat with flux. Take a long soldering tweezer and hold the joint. Find a comfortable position to rest the right hand, and, holding the torch in the left, heat the *spot on the brooch* where the solder was melted for the joint. When this solder becomes fluid again, lower the joint into place, keep the flame on the joint and brooch at the junction for another 5 or 10 seconds until the gleam of the melted solder shows a union, and then remove flame (see Fig. 22). Release the work when the red glow dies down. This requires co-ordination but should be quickly mastered. The catch is applied in a similar manner. Keep flux out of the moving parts of the safety catch, as the solder tends to follow the flux and the catch will then become inoperative. Be sure to mount the catch with the "mouth" down, or facing the bottom portion of the brooch.

The foregoing procedure may be modified somewhat in the following manner. Hold the joint in the tweezers, cleaned and fluxed, and heat to red heat. Apply a bit of solder from the end of wire solder to the bottom of the joint. Then heat the brooch at the proper point, which should have been previously cleaned and fluxed. When that portion of the brooch reaches bright-red heat, lower the joint, hold down until gleam of molten solder shows, remove flame, and release when red glow dies down. Follow same procedure for catch.

Protecting Findings Against Overheating.

Situations may exist where physical co-ordination is not of the highest order. This is particularly true when jewelry craft is a part of an occupational therapy program. Inexperience, as well, may make co-ordination less perfect in soldering operations. The result may be overheating the "finding," such as an ear-wire, catch, or joint.

An overheated ear-wire will result in a loss of "spring." The annealed metal will make the ear-wire practically useless. Joints and catches are sometimes melted. Although it is not advocated that the path of least resistance be taken, *when no other recourse is offered, however,* findings may be protected by loam.

The loam should be coated fairly liberally over the finding, excluding the area which is to be soldered. Dry the loam gently, and use usual soldering procedure. Should it be necessary to apply heat from the torch for a lengthy period, the coated finding will generally survive this operation with no damage. The loam may later be scrubbed off with an old toothbrush and hot water.

Soldering Gold and Silver in Combination.

When soldering gold and silver in combination, silver solder is used since gold silver generally melts at a temperature past the melting point of the silver portion. Gold and gold solders are rendered fluid at ranges between 1550° and 2000° F. A table of gold melting points will be found on p. 194.

Gold solders are available in three standard colors—yellow, white, and green. These solders are alloyed in varying degrees so that they can be matched for soldering different karat gold alloys. If, for example, a 14 karat job is being soldered, a 14 karat solder, of the required color, is specified. The designation of 14 karat on the solder does not mean that the solder is 14 karat gold, but that the solder is safe—will melt at a lower point—for 14 karat gold.

The temperatures vary with different-colored golds because of the varying alloys. White golds, because of their nickel content, melt at higher temperatures. Gold to be used for enameling purposes must be so specified when purchasing, because such golds must be free from zinc. The melting point of 24 karat (pure) gold is 1945°.

Providing a Source of Compressed Air for High Temperature Flame.

A major problem confronting the home craftsman is the difficulty in providing a source of compressed air for hard soldering and metal melting. This problem can be solved wherever an electric vacuum cleaner is available. All that is necessary is to remove the dust catcher—usually the bag at the rear of the machine. Turning on the motor will then produce a strong blast of air at the opening where the bag was connected (Fig. 23).

To "harness" the air for crafts purposes, this opening must be covered with a plate, containing a length of metal tubing to conduct the air to rubber tubing, which in turn leads to a torch or small furnace.

The best form of closure would be a large funnel. Probably the easiest construction involves the following:

A brass plate, "A," Fig. 23, is made to fit tightly over the bag opening.

This may be secured by the thumb screws normally used to hold on the dust-bag. A cork or rubber gasket, "B," can be used between the machine and brass plate. A commercial cement, such as "Miracle Adhesive," may be used to cement the gasket to the plate. In this brass plate a hole is cut, of large diameter. Over this opening may be soldered a tin funnel, "C." Thus, a unit consisting of a funnel-shaped air passage with a flat, brass, cork-covered flange results.

With this unit clamped in place, turn on the motor. A blast of air will emerge from the funnel end. This air leads to the air barrel of a gas-air torch. The gas tube leads, via rubber tubing, to its own source.

If the use of this device is contemplated in a kitchen, a handy man or a plumber can make provision for a gas outlet, where a gas stove is used, with very little labor and material—in some cases only the addition of a gascock.

Note: If the vacuum cleaner has a revolving brush, disconnect belt from pulley when using as an air source. Either tip machine on its side or raise about an inch off the floor to allow free intake of air.

Using the cleaner as an air source in *no way* injures the machine, or prevents quick re-arrangement for normal vacuum-cleaner use.

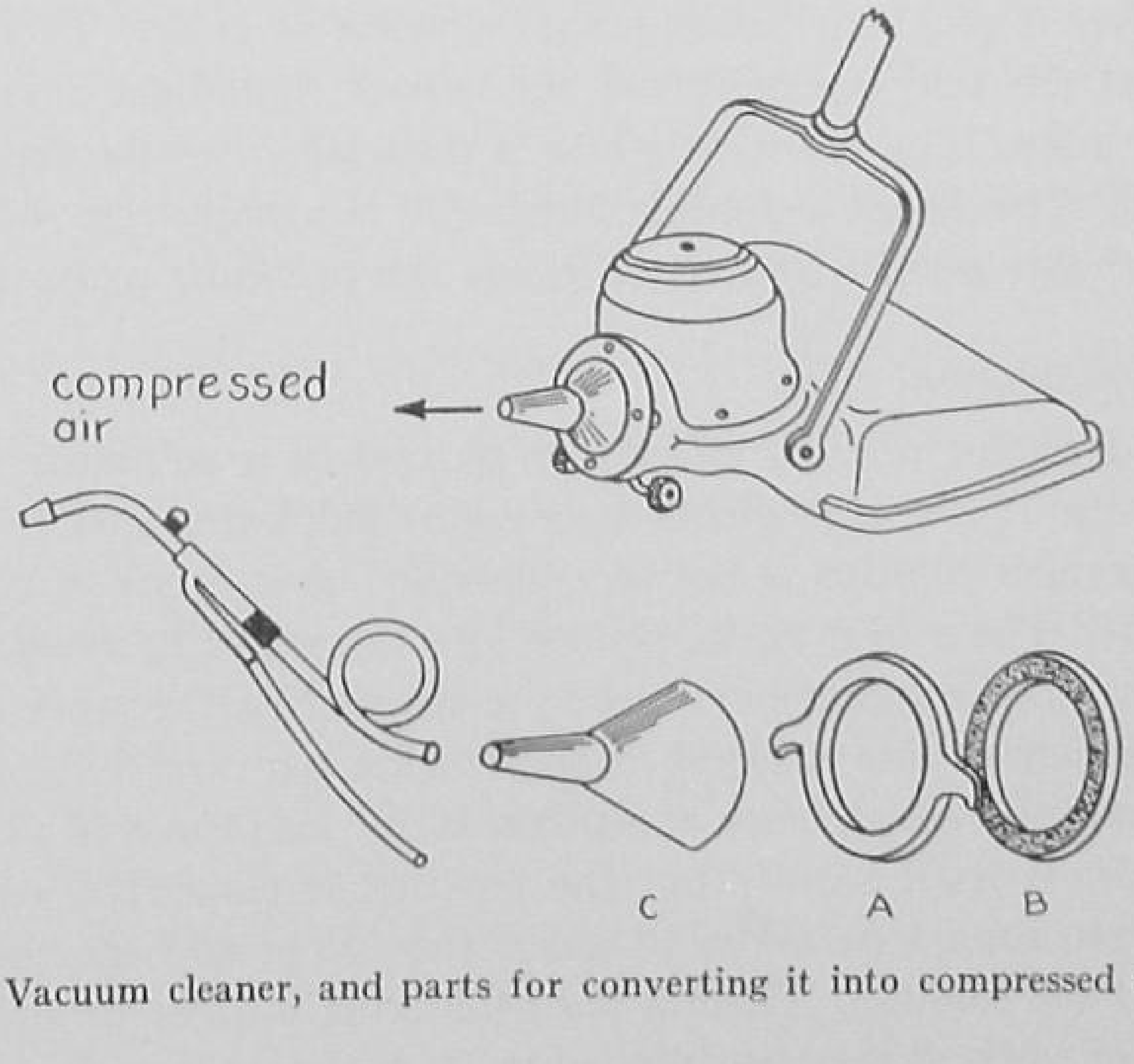


FIG. 23. Vacuum cleaner, and parts for converting it into compressed air blower.

Chapter VI

PICKLING, PICKLING SOLUTIONS, AND ANNEALING

Because of the oxides left by heating processes, such as annealing and soldering, and also because of the glazes and residue left by borax and other fluxes, it is necessary to use a pickling solution to expose a completely clean metal surface. Pickling is frequently done between successive soldering jobs to enable the worker to see clearly the degree of success in the operation. The acid used dissolves the glaze and oxides and exposes the work perfectly. Pickling is frequently done just prior to the polishing processes, just as a "bright dip" is used.

When copper is pickled, it emerges from the solution clean and somewhat pink in color. The natural copper surface appears when the metal is rinsed free of pickle and then lightly scoured with fine pumice or steel wool.

When silver is pickled, it emerges pure white in color. This is due to the fact that the acid has dissolved the copper ingredient used to make the sterling alloy. The resultant white is pure silver on the outer surface of the metal. This is not a durable finish and is usually removed by light scouring with fine pumice and water before the polishing process.

The Pickling Solution.

Silver and copper may be effectively pickled in a sulphuric acid solution. The ratio of the ingredients is one part sulphuric acid to ten parts water. A stronger solution is not recommended as it tends to coarsen the metal surface. The acid must be poured into the water to avoid a dangerous reaction. The solution is stored in a covered earthenware container. In use, it is poured into a heavy copper pickle pan and heated for best results. Sometimes metal, after annealing, is put into the cold pickle. The hot metal cleans itself readily but the reaction is somewhat more active and great care should be taken to avoid the fumes and splashing. It is safer to heat the solution. When a hard-soldering job has been done on a small piece of work, it may be dropped in its hot state into the pickle, but only if there is no iron binding wire on it, or loam on the joints. The iron

wire will cause discoloration. Cool the work and remove iron wire. The loam will prevent an even pickling and will make the pickle muddy. Scrub it off first with an old toothbrush. To avoid discoloration of the work, never use iron tongs for removing work from pickle. Use copper tongs. If a copper pickle pan is unavailable, a porcelain bowl or beaker may be used. Pour the pickling solution into the porcelain beaker before applying heat.

The work is carefully boiled until it is perfectly clean. Then it is removed with copper tongs and rinsed. Keep a container of clean water next to the pickle to avoid trailing acid along the floor. Dip into this container after pickling and then rinse thoroughly under running cold water. Avoid inhaling fumes from hot pickling solutions.

Pickle may be reused until it no longer reacts with the metal. Use at least enough pickle to cover the article.

Articles made of gold, 14 karat and over, are generally pickled in a nitric acid solution. The ratio is one part nitric acid to eight parts water. Pickling procedure is the same as with sulphuric pickle, but heat the solution in a porcelain beaker. Karat golds may also be pickled in the sulphuric acid solution, to which a small amount of sodium bichromate has been added. This will remove scale in cases where ordinary pickle will not do so.

A convenient device for handling small work that is to be boiled in a sulphuric acid pickle may be made as follows:

Secure a piece of fine-mesh copper screening. Cut this into a circle of required size, for example, 4″ in diameter. Work into shape with the fingers until bowl-shaped. This may be more easily accomplished if the screening is carefully annealed first. Make a circular rim of No. 8 or No. 10 gauge copper wire to fit the perimeter of the bowl-shaped copper "sieve" that has been formed. "Wire" the rim to the "sieve" with fine copper wire. Attach a copper wire bail handle and suspend this from a wooden stick. This makes it possible to place work in the pickling solution, remove it, and keep the hands out of the acid fumes at all times. Always rinse the sieve in clean water after use to forestall its eventual destruction by the "pickle."

Annealing.

Annealing is the process of softening metal by heating. It is an important process to the craftsman as the metal he works with will harden when hammered, twisted, drawn, or rolled through the rolling mill. This

hardening is sometimes desirable for stiffening a piece of metal. In such cases, the portion to be hardened is usually hardened by careful hammering with a polished flat hammer. The work rests on a steel plate during hammering, and the outline of the job may require reshaping by filing or sawing. Hardening by heat will be discussed later.

Annealing requires heat, the amount depending on the size, thickness, and type of metal in question. Usually a gas and air torch is employed for annealing. The work may rest on a charcoal block, which reflects the heat. Larger pieces of work are placed on a sheet of asbestos at least ½" thick or, better still, in an annealing pan. Such a pan may be improvised by securing any circular or square iron baking pan and filling it with lump charcoal or lump pumice. The work rests on the charcoal or pumice and the heat is played over the work. It is wise to do such heating in a space shielded with asbestos or transite to prevent fire.

To anneal properly, a piece of work is heated in a blue flame until it is evenly heated to the proper degree, which may be determined by its incandescence. Silver, gold, and brass are heated to a dull red. Brass should best be quenched in water at 1000°. Overheating it causes a loss of its zinc content through volatilization. Copper may be heated to a salmon red.

Aluminum is heated to a dull pink. The heating should be done evenly, by keeping the flame moving over the work. This will reduce the possibility of melting one portion of the work before another part becomes red. It also reduces the possibility of warping. Silver and aluminum in particular should be annealed in a subdued light because the color of the metal makes it difficult to see the proper annealing color.

To obtain the maximum softness of sterling silver, heat to 1400° F. and quench immediately. Remember that at 1400° F. silver appears cherry red. The quenching may be done in cold water, which must be located in a container directly at the source of heat to make instant quenching possible. If facilities for *instant* quenching are not available when annealing, do not heat the silver over 1200° F. At this temperature (dull red), silver may be left to cool in air and will be found sufficiently soft for most purposes. When sterling silver is heated above 1250° F. and cooled in air, it will be found that there has occurred a definite hardening effect rather than annealing.

Always remember that a piece of work with small, delicate parts requires careful annealing to prevent melting these parts.

If speed of production is an important element, the heated, annealed metal, with the exception of gold less than 14 karat, may be quickly cooled

by immersion in cold water or an acid pickle. In such a case, immerse the work quickly—gradual immersion tends to increase warping or distortion of the metal.

If, when annealing, it is important for some reason to prevent oxidation, a thin coat of boric acid, in water solution, may be applied to the work before heating. After annealing, any traces of the solution may be washed off in hot water.

Annealing Wire.

When it is necessary to anneal lengths of wire, which is frequently the case to make it workable, the wire may be coiled in a circle to form a tight 2″ or 3″ ring. If the wire is No. 18 to No. 14 gauge, it may then be heated with the torch. If lighter than No. 18 gauge, it is wise to enclose the coil, sandwich-like, between two sheets of No. 24 or No. 26 black iron sheeting, cut into 4″ squares. The "sandwich" is then tied cross-wise with No. 22 binding wire. Both sides are heated, in turn, to a red glow. Cut the binding wire, remove the wire, and cool, or immerse in pickle.

When annealing, remember to adjust the torch to a blue flame, but avoid the bright blue cone at the center of the torch tip. This would show the presence of too much air, and would cool the work rather than bring it rapidly to red heat. Also avoid annealing any metal with soft solder on it. Such solder will melt and the lead present will eat into the surface of the metal being annealed. For this reason, it is wise to clean a piece of metal with emery cloth or steel wool, if the metal has been hammered on a lead block.

A worker with limited experience in annealing should slowly move his torch towards, and then away from his work, observing carefully the distance at which he gets the most intense heat.

In closing, it might be well to warn against applying this annealing procedure to all metals. Steel, for example, when heated to a red heat and immersed in cold water, will become extremely hard and brittle. (See Chapter on chasing tools.)

Heat-Hardening Silver.

The most accurate means of hardening silver necessitates the use of a small furnace equipped with a heat measuring device, such as a pyrometer. If this equipment is available, the following procedure will produce an appreciable hardening effect on a soft piece of silver.

Heat the silver to 1400° F. and quench it *instantly*, in water. (Allow

no *gradual* drop in temperature.) The work is next heated to about 600° F. and "soaked," or held at that heat for 15 minutes. When next cooled in *air*, it will be found to be in a hardened state. The importance of a furnace will be noted particularly during the 600° "soaking" period, this being a procedure difficult to attempt with a torch.

The hardening process is useful when a piece of work is found to be annealed due to various soldering operations. If this is the case, and the hardening procedure is used, it may be well to protect soldered joints with loam before subjecting the work to the first part of the hardening process —heating to 1400° F.

Chapter VII

BUFFING, POLISHING, AND LACQUERING

The Machine.

In order to give an article of jewelry a completely finished appearance, it is generally necessary to polish it on a polishing lathe or buffing machine. For good results, a machine utilizing an electric motor of ¼ to ⅓ horsepower will suffice. A larger motor is unnecessary for jewelry; a smaller one does not do very well. The motor speed may be in the neighborhood of 1750 r.p.m. For a high polish with a muslin wheel, speeds of 3000 and 3500 r.p.m. may be used. If the motor is not a variable-speed, or two-speed, machine, speeds may be changed by using the motor to drive a polishing head. A 2- or 3-step pulley on the motor shaft belted to the polishing head will suffice. The polishing head or the buffing machine should be equipped with two tapered, threaded arbors to hold buffing wheels. The wheels used vary but the bristle, muslin, leather, and wire wheels may be 3″ or 4″ in diameter for most work.

Lathe splashers or metal shields mounted over the arbors will protect surrounding objects from being spattered with materials from the wheels. Do not rely on them as safety guards. That is not their purpose. The height of the motor arbor from the floor should be about 12″ to 14″ below the eye level of the operator.

The Abrasive Compounds.

An article is buffed and polished by applying it with a firm pressure against a wheel charged with an abrasive, which rotates in the direction of the operator. The wheels are "charged" by holding the stick of abrasive compound against the whirling wheel for a few seconds. Do not overcharge a wheel, as dirty work will result.

The compounds available are varied:

Jeweler's rouge is used for the final high polish or "color" on gold and silver. It is generally red in color, although white rouge is also available. Some claim white rouge leaves a less noticeable residue. However, a careful worker removes *all* residue.

Tripoli, a tan-colored, clay-like compound, is the most generally used cutting compound. It will remove slight scratches and leaves some luster. It is actually a finely granulated siliceous rock, called soft silica. Tripoli is quarried in Missouri, Tennessee, Georgia, and Illinois. For "buffing" compositions, O.G., or "once ground," tripoli is used. "Air Float" is the finest grind and will make a polishing compound. D.G., or "double grind," grade is frequently used as a parting powder in casting operations. Some workers prefer the less brilliant finish of tripoli to that left by rouge. Remember that tripoli is a *cutting* compound and, if a wheel charged with it is used carelessly, part of the work, or detail, will be quickly worn away.

White Diamond compound is used for both cutting down and polishing operations though the two separate operations are preferable.

Crocus Composition is a fast-cutting compound. It may be used on steel, as well as the non-ferrous metals.

Emery Paste composition is also a fast-cutting compound for the common metals.

Pewter Coloring Compound is used on pewter and lead-bearing metals.

It is safe to say that the use of tripoli, after the noticeable scratches have been removed by hand methods, is a good preliminary polishing operation. This is followed by the rouge polishing operation, for a final high color.

The Wheels.

A great variety of wheels is available for a variety of commercial uses. Most of them will be mentioned here, though only a few will be found necessary for the average craftsman. Most common is the *muslin buff,* for final rouge polishing. This is a wheel made up of loose circles of fine muslin, held at the center by a lead piece with a hole through it. The muslin buff is also commonly used without a lead center, the circles of muslin being stitched through and through in two or three rows of stitching of different diameter. This gives a slightly stiffer wheel. It is used with either cutting or polishing compounds.

Cotton polishing wheels, made of cotton yarn radiating in several rows from a wood center, are also used for final rouge polishing.

Cotton flannel buffs, stitched as described previously, are used for final polishing.

Woolen buffs, made of stitched wool cloth, are used with various cutting compounds.

Solid felt wheels are used with either cutting or polishing compounds. These wheels come in a variety of shapes and diameters. The common flat type presents a straight edge to a surface and is used when the operator wishes to avoid the spreading and consequent overlapping encountered when using cotton and muslin wheels. The felt wheel is particularly useful for polishing around bezels and "stepped" surfaces. The felt wheel is also available in a knife-edge style for polishing in narrow crevices.

Stitched leather wheels are used for rough cutting operations, as are Walrus Hide wheels.

Felt cones, both pointed and round, are used for polishing inside cupped depressions.

Felt ring buffs are used to polish inside finger rings. A ring buff made of wood, over which special abrasive-paper shells fit, is also used for finger rings.

Solid grit lathe cones are similar to the ring buff, but are made of solid corundum, with a lead center for mounting. These cones are used for grinding inside rings.

Wood laps are wheels of varied profiles, which are charged with different abrasive powders, in conjunction with oil or water.

Brightboy wheels are a patented product which may be described as a form of rubber and grit compound. This compound is furnished in wheel form and in block or tablet form. The wheel is mounted and run at moderate speed for fast-cutting jobs, never for polishing. The tablet is useful for hand work in removing blemishes from a metal surface.

Bristle brush wheels come in many forms. The most common for the jewelry worker is the ordinary bristle wheel, shaped like any other polishing buff, but consisting of stiff bristles set in rows, radiating from a wooden hub. Other shapes are made for working inside goblets, around handles, inside rings, etc.

The bristle brush is useful for working on articles with many recessed portions. The wheel is charged with tripoli. When used with various compounds, it may also provide a variety of textures or finishes on smooth metal objects.

Scratch brushes are available in either brass or steel. These brushes, as far as the jeweler is concerned, will provide a variety of textures or finishes on metal surfaces, such as satin finish, dull finish, or mat finish.

It is inadvisable to use a brass brush on a silver metal, as a slight brass coloration remains on the silver surface. Wire brushes are made with straight and crimped wire. In general, the crimped wire brushes give a

somewhat softer finish, although the many different effects which can be obtained will also depend on the size of the wire used in the brush, the pressure of the brush on the work, and the speed of the polishing lathe.

Using the Machine.

When using the buffing machine, one must first take certain precautions so as to avoid injury as well as discomfort. First, no flowing clothing, loose ties, or long hair must be near the machine. Wear an apron high up, close under the chin. Wear goggles, or preferably, a clear plastic mask or shield. The polishing compound will be present in minute particles in the air around the machine and a mask will keep these particles out of eyes, nose, and off the face. Sleeves should be rolled above the elbow. The work and wheel should be well illuminated. If much work is to be done, thorough ventilation should be provided for.

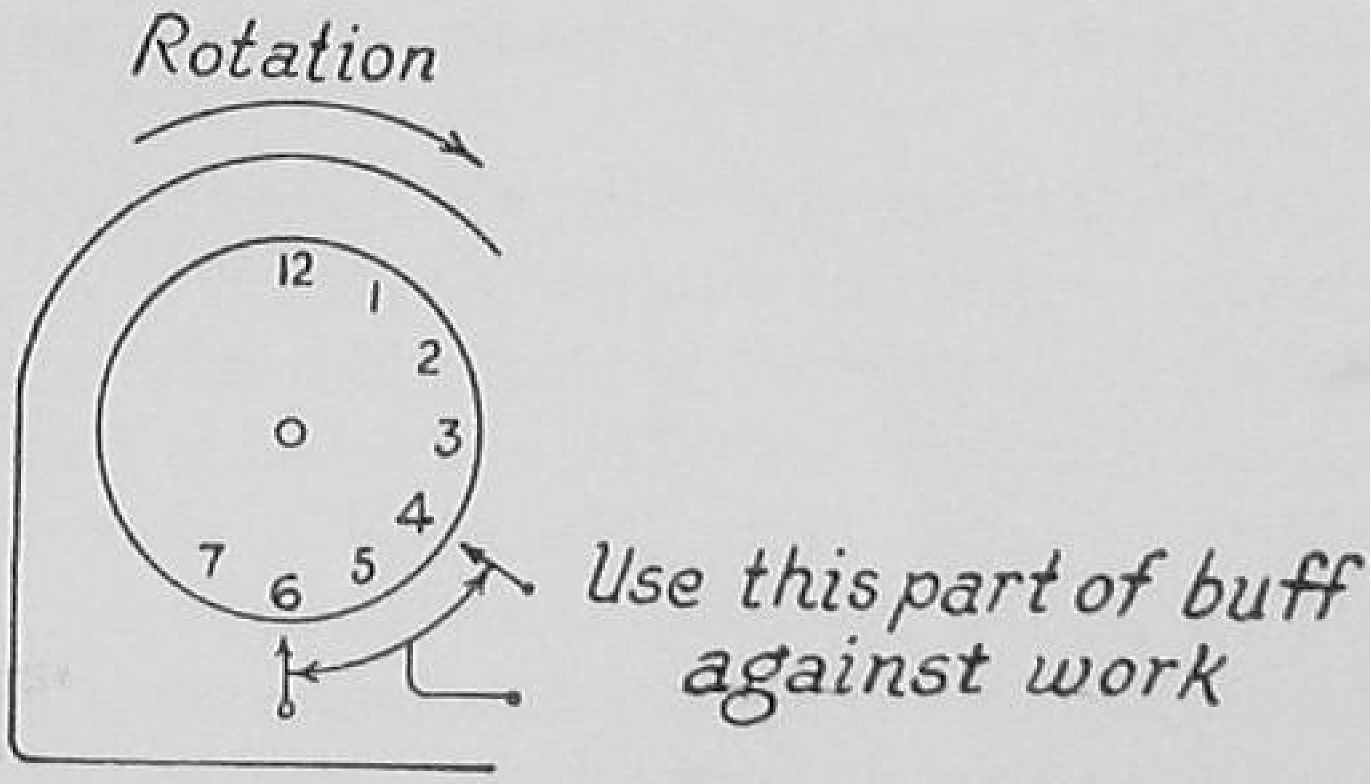


FIG. 24.

The portion of the wheel used for buffing is shown in the diagram (Fig. 24).

The wheel is shown as a clock dial. The work is held against that segment of the wheel marked off by the numerals 4 and 6. Using any part past "6" is not practical. Using any portion before "4" is extremely dangerous. Note the direction of rotation. If the work is held above "4" it will be thrust violently toward the operator. Below 4 it may possibly be snatched away, but if precautions are taken, it will merely be thrown into the dust collector or against the splasher.

The polishing lathe is a dangerous machine—particularly because of its seemingly innocuous soft wheels. The wheels, however, do not make the injuries; they cause them.

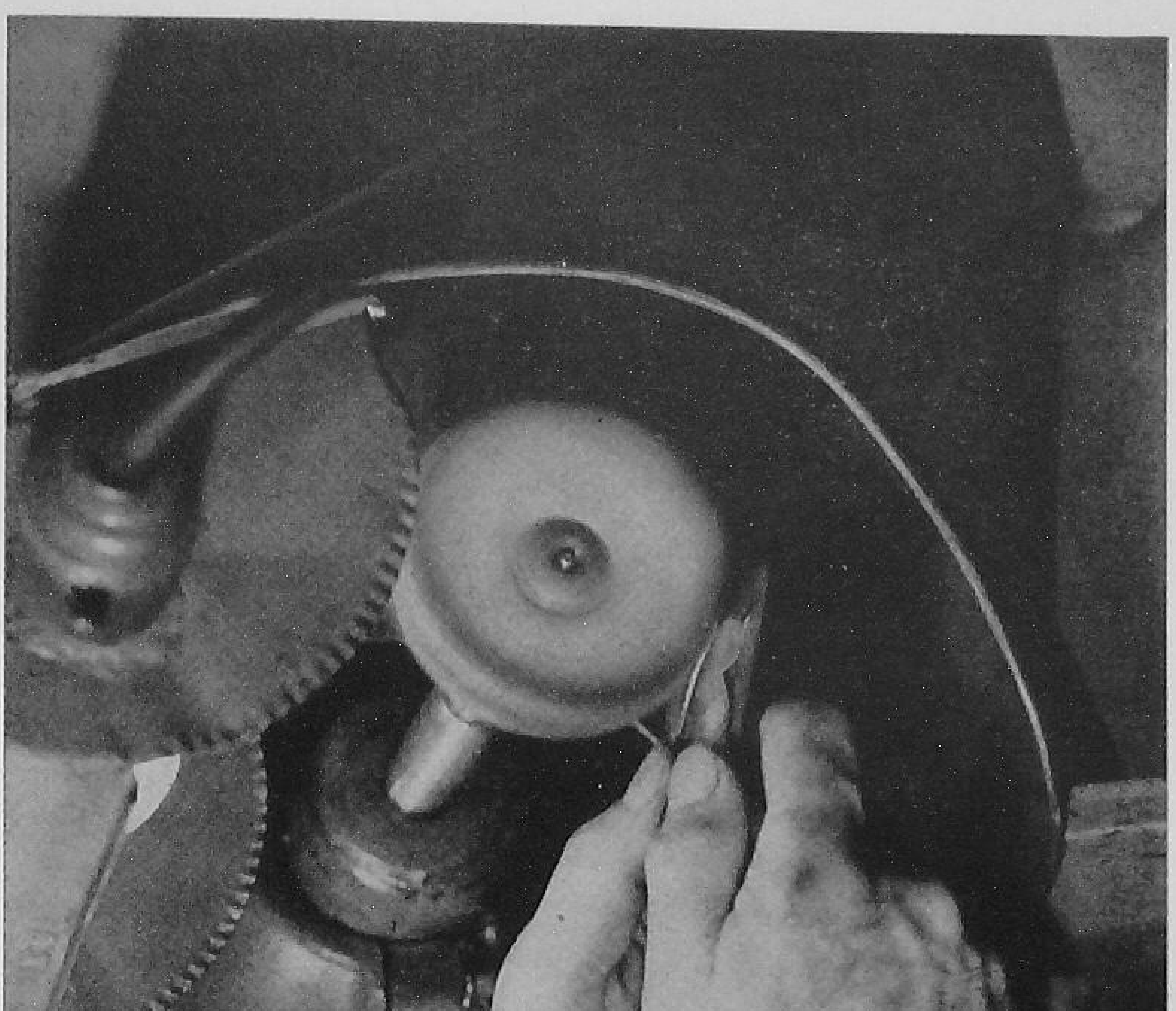


FIG. 25. The work being buffed is supported here on a flat stick.

Because of the occasional "snatching" action of a wheel, work should be so held that if it were to be suddenly and powerfully torn from the grasp, no injury would result to the operator. This means avoiding the edges of the work as a means of holding. It means avoiding hooking a finger through a ring or bracelet when polishing. Fragile work can be rested on a small flat stick to avoid bending, and to make holding easier (see Fig. 25).

A typical job of polishing can be described as follows:

If the work has been soldered, it should be pickled before buffing is attempted. All scratches are removed by use of files, Scotch stone, abrasive papers. A stitched muslin buff is then charged with tripoli and the work given a careful buffing to remove all slight imperfections. It is at this stage that the novice is amazed by the emergence of the real beauty of his work. If the character of the article requires it, a bristle brush charged with tripoli is used for cleaning recessed areas. If hard felt wheels are necessary for inaccessible areas, they are employed now. At this point, the particular worker will wash his work in a strong, hot solution of soda, with a slight amount of ammonia added. To 1 gallon of hot water add about 1 ounce of ammonia and ½ pint caustic soda or lye. Use rubber gloves here. This step will remove all traces of tripoli and other foreign matter. If these impurities remain, they will be transferred to the rouge buffing wheel, and will not only defile that wheel but will prevent a really fine finish from resulting. If the work has recessed areas, a hand bristle brush or an old toothbrush may be used, together with soap and hot water, to completely clean the article. Now rinse and dry. If compressed air is available at the soldering bench, it may be used to blow all moisture out of the recessed areas, as well as to hasten drying. Some jewelers use clean, boxwood sawdust for drying. The work is placed in this after washing. It will dry quickly with no discoloration.

Rouge is now applied to a cotton flannel buff or a loose-type muslin buff, and the work is brought to the required degree of luster. The work may now be washed as previously and dried before lacquering.

At this point it should be emphasized that different compounds should not be used on the same wheel. Using rouge and tripoli on one wheel will make it unfit for fine polishing.

A rouge wheel accidentally defiled by tripoli may be used from then on for some cutting compound other than rouge, but when that cutting compound is used, the wheel should be reserved for that compound alone. A

means must be used to identify each wheel according to the compound used, either by storage means or by markings.

Buffing by Hand.

In some instances power is not available or the craftsman works on so small a scale that power equipment is not included among his paraphernalia. Such a worker can get good results by the use of hand buffing equipment. It requires merely more time and more energy.

The preparatory steps, utilizing files, Scotch stones, brightboy tablet, abrasive cloths, etc., take the usual order. Improved results in the use of crocus cloth and rouge paper can be obtained by purchasing prepared flat sticks coated with crocus paper or by making these. Secure sticks from 10″ to 12″ long, 1″ wide, or less—depending on the type of work—and about $\frac{3}{16}$″ thick. Thinly coat one surface with a good grade of glue for a distance of about 6″ and apply crocus paper or rouge paper. Keep it flat. Prepare a good supply of these as it is more economical than purchasing such equipment. These sticks are used prior to buffing.

Sticks for buffing and polishing are available commercially or can be made by using the same sticks and gluing a strip of soft leather—unfinished side out—to the wood. Buckskin and chamois are frequently used for this. Other sticks may be covered with a strip of white felt. These sticks are used by rubbing them against the needed buffing compound and then applying them vigorously to the work. Use like a toothbrush but with a longer stroke and emphasis on the forward stroke. The writer has found such sticks useful when covered on two sides—each for a different compound, or one side crocus paper and one side felt or leather for polishing.

Orange sticks of various diameters and about 6″ long are useful for getting into hollows where no wheel can reach. The ends of such sticks are charged with abrasive and then rotated by the fingers or rubbed against otherwise inaccessible areas. Jeweler's rouge in paste form is useful for polishing by this means. Emery paste compound makes a good cutting abrasive for these sticks. Final over-all polishing of hand-finished work can be done with a good chamois skin or commercially available prepared polishing cloth.

Use of Lacquer.

When it is desired to preserve the finish on a piece of jewelry, regardless of whether that finish is highly polished, chemically colored, satin dipped

or brushed, a coat of thin transparent lacquer is applied. Explained simply, this finishing process coats the article with a thin, clear, tough layer of celluloid in liquid form. When the solvent evaporates, a layer of celluloid remains, separating the metal surface from further contact with air, thus maintaining the finish imparted by the craftsman.

Some craftsmen rub a thin layer of wax over their work. As a preservative measure, this is not particularly useful. Its only merit is that its surface luster is not as high as that of lacquer. And as the degree of luster is a matter of personal taste, the wax method may seem to some to have no merit. Work that is to be on display for any length of time needs a lacquer finish for practical reasons, since an article not being worn will tarnish more rapidly than one exposed to the rubbing of clothes. Some do not use any coating or preservative and rely on constant use to keep the article of jewelry properly burnished. This results in the proper oxidizing and high lighting of a metal ornament by natural means. When such an article is out of use for a while, it may be brought back to desired finish by simple use of a prepared polishing cloth.

Lacquer in its most elementary form can be made by dissolving clear celluloid in acetone or amyl acetate. The solution should appear only slightly heavier-bodied than water. Remember these solutions are inflammable.

A good lacquer should be purchased from a reliable dealer in metal finishes since good, tough lacquers are carefully compounded. The thinner for this lacquer should be purchased from the same source. Lacquer thickens after a period of time in the bottle. The lacquer may appear slightly amber in color. This does not show up on the finished article if properly thinned and applied. When lacquer is purchased in quantity, a small amount—3 or 4 ounces—may be kept aside for use, properly thinned. If this mixture is kept in a well-stoppered clear jar, it can be observed for thickness and cleanliness. If for any reason the mixture becomes poluted with any foreign matter, the jar can be rinsed with thinner and a new supply added from the large, original store. In the small shop, a set-up similar to the one in the photograph can be used (Fig. 26). This will mean that brushes are always soft and clean, the necessary items are always on hand, and the jars will not tip easily. The surface of the wooden base is recessed for jar and brush vials. The vials are stoppered with a unit consisting of a rubber stopper and brush. To make this unit, heat a nail, slightly less in diameter than the brush handle, to a dull red. Then pierce the stopper through the center. Soft rubber will appear melted

around the nail, which may have to be reheated a few times. When the nail comes through, push the pointed top of the brush handle through the hole in the stopper from the bottom, until only enough brush extends from the stopper to reach about one-third to halfway into the vial. The soft rubber will solidify, sealing the brush into the stopper permanently. If enough thinner is kept in a vial to partially cover the hairs of the brush, it will always be in good condition. Change the liquid when it thickens to any extent.

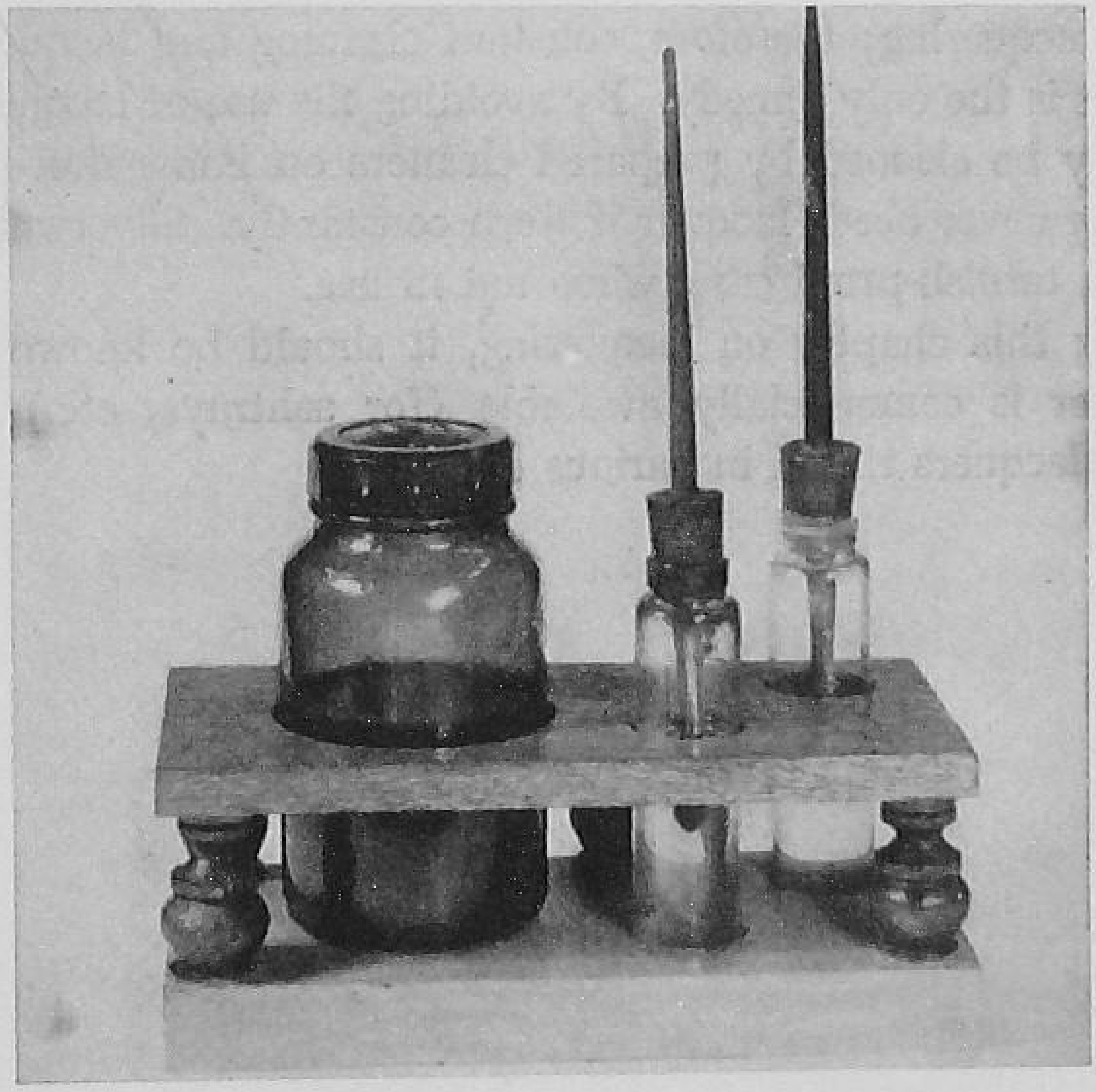


FIG. 26. A convenient rack for lacquering equipment.

Lacquer is applied in slow, smooth strokes, like nail polish. Don't go over a stroke. Don't work where dust has been agitated into motion. If a beginner has no luck with the first few attempts, the lacquer may be removed by rinsing with thinner. If the lacquer turns a cloudy white, water is present on the article being lacquered or the air is unusually moist. If a dirty, cloudy appearance results from lacquering, then a residue from the polishing wheel has remained on the article. Remedy this by properly washing the finished work, and then allow it to dry. The grease content of an abrasive compound will occasionally cause a slight rainbow-like effect on the lacquered work. A washing of the work in the proper caustic

bath will remedy this too, and it may be necessary to rinse the brush thoroughly with thinner and use fresh lacquer.

Lacquer may be sprayed if made very thin. This is done in quantity production. Avoid the presence of flame or moisture, and make certain of good ventilation for health reasons.

Articles like finger rings and silverware, which receive abuse by much contact with hard objects, should not be lacquered. Even a good, tough lacquer will chip in spots when subjected to rough usage. These spots will tarnish, making unsightly blemishes. It is impossible to clean individual spots for relacquering; therefore, constant cleaning and lacquering of the entire object is the only remedy. By avoiding the use of lacquer on silverware, it may be cleaned by prepared cleaners on immersion in a special bath. A ring never needs lacquer if worn constantly. Silverware may also be kept in a tarnish-proof case, when not in use.

In closing this chapter on lacquering, it should be known that heat-proof lacquer is commercially available (for ashtrays, etc.) as well as transparent lacquers tinted in various colors.

Chapter VIII

DIPS AND OXIDIZING OR COLORING SOLUTIONS

Oxidizing, or the combination of the elements in the air with the metal, takes place when the silver, copper or brass used in jewelry are exposed to air. The process takes place more rapidly during heating operations, *e.g.*, during annealing and soldering. Gold does not oxidize so readily although it can be oxidized. This natural process may be desirable or undesirable. If the latter, the work is protected by lacquer. If the former, it is permitted, but usually under conditions whereby it may be controlled.

When oxidizing, or "antiquing," a piece of jewelry, the following should be borne in mind: To give apparent depth to a relatively flat design, or to cause a contrast between the different elements of a design certain portions of the design may be darkened while others are brightly polished. Most often, the recessed portions are left dark while the raised portions are polished.

When the proper oxidizing solution has been decided upon, the article, if small, is either dipped into the solution or swabbed with it. When dry, the article being antiqued is polished in the following way: The finger tip is moistened and touched to a dish containing some whiting, which in this case acts as an exceedingly fine abrasive. The finger is then rubbed over the raised portion of the work, where it removes the unwanted oxide. When this is done to the proper degree or to the taste of the craftsman, the work is rinsed and dried by a current of air. Do not heat, because an oxide will rapidly re-form.

A small, soft hand buff with a very light application of rouge is then buffed over the raised surfaces, bringing up full luster if this is what is wanted. The work may then be wiped clean with a polishing cloth and lacquered, if so desired. If the work is not lacquered, the oxidized portions will not be affected, but the bright portions may dull if the article is not worn sufficiently. This is easily remedied by the occasional use of a polishing cloth.

Interesting effects can be obtained by oxidizing an entire flat surface and following this with steel wool applied in long strokes across the work,

in one direction. Other effects based on similar action will suggest themselves.

An important point to bear in mind before any oxidizing is undertaken is that the work should previously be finished and buffed to perfection, and then most thoroughly cleaned by either caustic bath, soap and water, or a bright dip. Oxidizing is sometimes used on cheap commercial work to cover poor finishing. However, this process used on work meticulously done is a very important factor in accomplishing a really artistic job.

Dips.

Sometimes, before oxidizing is done, an article is rendered completely free of all foreign matter by the use of a "bright dip." This is usually done before metal plating and enameling as well. In either case, it assures a smooth, even process. The "bright dip" may be made up in several ways. Any or all of the following may be tried:

Sulphuric acid—1 part
Nitric acid—1 part

or

Sulphuric acid—2 parts
Nitric acid—1 part

or

Hydrofluoric acid—1 quart
Nitric acid—1½ pints
Sodium chloride (common table salt—2 tablespoons)

Work should be suspended in the solution up to about 30 seconds, at the most. Watch carefully and use the shortest time necessary. Do not suspend the work by iron wire; use copper or brass. Rinse work in cold running water immediately upon removing work from any of the dips mentioned in this section, then dry. Use rubber gloves and avoid any contact with the acids. Have good ventilation. Do not keep such dips where children may be present. When any dip using hydrofluoric acid is made, the container should be of glass or crockery that has been *well coated with black asphaltum varnish,* obtainable at paint stores. Glass or crockery alone is attacked by hydrofluoric acid.

Satin Finish.

To secure a satin finish similar to a wire-brush finish, a satin finish dip may be used in the same manner as previously described but using any one of the following solutions:

Hydrofluoric acid—1 pint
Water—3 pints

or

Hydrofluoric acid—1 pint
Nitric acid—½ pint
Water—5 pints

or

Hydrofluoric acid—2 pints
Nitric acid—1 pint
Muriatic acid—½ pint
Water—5 pints

When dips using acid and water are prepared always add the *acid to the water* to avoid possible violent reaction.

Satin dips may be used either to secure a straight satin finish or in conjunction with an oxidizing process.

"Gold" Finish.

To secure a finish on brass similar to gold, the following is commercial practice:

Suspend work as previously described, until desired color is obtained, in this solution:

Nitric acid—2 pints
Hydrofluoric acid—2 pints
Clean zinc scrap—2 ounces

Rinse and dry.

Oxidizing or Coloring Solutions.

Probably the most common oxidizing agent in use on silver and copper is potassium sulphide, or, as it is often called, "liver of sulphur." This

will give silver or copper a blue-black to black finish. The solution of this chemical for oxidizing is made as follows:

Dissolve 1 ounce of potassium sulphide in 1 quart of hot water. About a quarter of an ounce of ammonia may be added, although this is not essential. Dip or swab the article to be oxidized in this solution. If the article is preheated by previous immersion in hot water, better results are usually obtained. Should a "scaly" black result, the mixture is too strong and more hot water may be added to weaken it. Potassium sulphide comes in lump form and should be kept in a tightly closed *dark* jar or can.

Dry the article, preferably by air pressure, and treat as described earlier in this chapter. Another solution that will work in similar fashion may be made by adding ammonium sulphide (a liquid) to water until a light straw-colored solution results. This solution may be used upon being heated.

Butter of antimony may be applied to brass and allowed to dry. This will oxidize brass very well.

To secure a brown finish on copper, about ⅔ of an ounce of potassium oxalate and 2 ounces of sal ammoniac are dissolved in a pint of white vinegar. The article to be colored may be immersed or swabbed with a cloth.

For a red finish on copper, to 1 pint of water add 1 ounce of potassium carbonate and 2 drams of sulphide of arsenic.

To secure a steely-gray coloring solution for copper, dissolve 2 ounces of chloride of arsenic in a quart of water. The article to be colored may be immersed in the hot solution.

An interesting range of colors in succession can be produced on copper by dissolving 300 grains of lead acetate and 600 grains of hyposulphate of soda into 1 quart of water. The solution may *then* be heated to the boiling point for use. By continued immersion, steel gray, purple, maroon, red, and gun-metal blue may be produced in succession. To stop at any color, quickly remove from bath and immerse in warm water. Dry and lacquer.

For a bronze finish on copper, dissolve 3 ounces of iron nitrate and 1 ounce sulphocyanide of potassium in 2 quarts of water. Immerse the work or swab with cotton swab.

For copper, brass, and bronze, an antique green patina similar to that seen on bronze statues or copper roofing exposed to weather may be secured by any of the following solutions:

On brass or copper: To 1½ quarts of water, add 1 ounce of sal ammoniac and 3 ounces of ammonia carbonate.

Another solution is made by adding to 1 pint of water the following:

1 oz. iron chloride crystals
3 oz. verdigris (basic copper acetate)
5 oz. sal ammoniac
2 oz. cream of tartar
4 oz. sodium chloride (common salt)

Dip the article and allow it to dry naturally.

Still another solution is the following: To 24 ounzes boiling water add:

6 ounces cream of tartar
2 ounces sal ammoniac
16 ounces cupric nitrate
6 ounces sodium chloride (common salt)

On brass, copper, or bronze, the following may be used: To 20 ounces acetic acid add:

2 ounces water 10 ounces sal ammoniac 2 ounces cream of tartar 2 ounces copper acetate 2 ounces sodium chloride (common salt)	Apply with stiff brush.

To give brass a golden bronze color, 1½ pounds of potassium nitrate are dissolved in 1 quart of sulphuric acid. To this are added 1 gill nitric acid and 1 gill hydrochloric acid. Immerse work.

Brass may be given a greenish hue by dissolving ½ pound sal ammoniac and ½ pound copper sulphate in 2 quarts of boiling water. This solution is applied with a stiff brush and permitted to dry naturally.

To color brass steel gray, 2 ounces of arsenic chloride are dissolved in 1 quart of water. The work is immersed.

Colors ranging from brown to red may be applied to brass by dissolving in 1 quart of water 4 ounces of iron nitrate and 4 ounces of sodium hyposulphite.

Although aluminum is not frequently used for jewelry, its occasional use may necessitate the mixing of an oxidizing solution. Such a formula is the following:

To 1 quart of hot water add ½ pound zinc chloride and ½ to 1 ounce of copper sulphate, the amount depending on the speed of action wanted. Articles are immersed. The aluminum may be cleaned again by immersion in a weak solution of caustic soda (lye).

Gold may be oxidized by a commercial fluid called "Hil-Ox," obtainable at a jeweler's supply house. Gold may also be oxidized or colored by first making it hot, and then with a soft brush, such as camel's hair or fitch hair, applying a warm ammonium sulphide solution, such as used for silver oxidizing. The article is then rinsed and polished. No lacquering is necessary.

Before leaving the subject of oxidizing metals, it should be known that copper can be given beautiful coloring by heat. The results here are not too predictable, although they are varied and often quite brilliant. Such a coloring method is excellent on copper simulations of leaves and flowers.

To use this method the copper should be polished, washed thoroughly and dried. It is then heated slowly over a clean, blue gas flame. If first results are not satisfactory, merely clean off the resulting oxide and try again until an effect sufficiently satisfying is obtained. Dip in cold water when this effect is obtained, dry in air stream, and lacquer.

Substitutes for Metal Plating.

The craftsman who is producing work on a small scale may not have plating equipment at his disposal, although the cost of a small plating outfit is not prohibitive. If such is the case, he may wish to try substitute methods for gold and silver plating. It is well to remember, however, that although nice effects can be obtained by these methods of gilding and silvering, they are not comparable to electroplating for lasting results.

Gilding.

For gilding, it is first necessary to make chloride of gold. This is done

by dissolving gold in a solution composed of equal parts of nitric acid and muriatic acid. Dissolve about 6 pennyweight of gold to 1 pint of the acid mixture. The resulting liquid is chloride of gold. The chloride of gold is then used in either of these two formulas:

5 oz. cyanide of potassium
2 pints chloride of gold
6 oz. washing soda crystals (sodium carbonate)
2 quarts of water

The clean work is immersed in the boiling solution for a few moments, or until desired color appears.

A second formula:

To 1 quart of distilled water, add 1 pint chloride of gold. Then add 16 ounces of potassium bicarbonate. Heat over flame for about 1 hour, keeping the solution just short of actual boiling state. Immerse work into warm solution as above.

Silvering.

For silvering on copper, various interesting effects other than the all-over silver coat, will suggest themselves. For example, an article with an etched design may be silvered. The silver may then be partially removed, allowing it to remain only in the recessed portions. To remove the silver on the higher surfaces, make a buff by wrapping three or four layers of cloth tightly around a wooden block small enough to fit the palm of the hand. Evenly charge the surface of the dampened cloth with a very fine abrasive powder and rub in even strokes. Wash and lacquer.

Silvering formulas in paste form are:

7 drams cream of tartar
80 grains silver nitrate
40 grains sodium chloride (common salt—fine grain)

Mix with water to a paste and apply to clean copper with a pad or daub. Rub with pad until satisfactory coating is obtained.

Another method is to set a small jar containing 1 ounce nitric acid and 1 ounce silver scrap in a warm place. When the silver is entirely dissolved, mix with sufficient cream of tartar to form a thin paste. Both copper and

brass may be silvered with this paste. Apply with pad, rubbing until a satisfactory coating appears.

Remember in dealing with chemicals that many are poisonous. Observe the labels. Keep chemicals in containers similar to the ones in which they were obtained from the chemist. Good ventilation is advisable when mixing formulas. The use of rubber gloves is recommended in general. Good results are most often dependent upon the use of fresh chemicals, provided, also, that proper preparation has been made. In the absence of suitable measuring equipment, these formulas may be mixed by any local chemist.

Chapter IX

DOMES AND SHOT

Domes, or hemispheres of metal, and shot, or balls of metal, are frequently used to give depth and richness to pieces of metal jewelry. Sometimes such ornamentation is used in conjunction with stones; at other times, domes or shot are used in lieu of stones—either single or in groups forming a pattern (Figs. 27 and 28).

Shot.

Shot is so-called because of the similarity of the process used to that used in the making of shot or ball for firearm use. In Boston, a shot-tower still stands, a relic of Revolutionary days. At that time, quantities of molten lead were dropped from the tower into a trough of water below. The molten lead became spherical in shape during its fall, and solidified before hitting the water, in which the shot was chilled as well as protected from injury.

The craftsman makes shot by melting a pre-determined amount of metal, dipped in flux on a charcoal block. It is made in sizes ranging in diameter from a pinpoint to about $\frac{3}{16}$". To obtain as nearly spherical a shape as possible without resorting to a shot-tower a small depression may be made in the charcoal block with a dapping punch of small size. This will allow the base of the ball to maintain its curvature in the solid as well as in the molten state. The metal, usually wire or scrap bent or compressed to occupy a small space, is heated in a blue flame until it is molten and appears to "spin." It is then allowed to cool, and when redness disappears, it may be dropped into pickling solution or suspended in a copper sieve, as described under "Pickling."

Some difficulties arise when an oversupply of borax flux is used. The flux itself forms a molten liquid and adheres to the shot, distorting its form. The remedy for this is to use a thin flux, not too abundantly. Sometimes the small shot is blown away from the surface of the charcoal block by the flame. When this occurs, it is evidence of too intense a flame, and the torch should be adjusted to a quiet, blue flame.

Frequently the use of fine silver is advised in the making of shot because of its slight advantage in luster. The author does not advise this usage for two reasons. First, the fine silver does not wear well, and shot, being particularly exposed in its usual application, must withstand much wear. The second reason may be explained as follows: When fine silver is melted it absorbs considerable oxygen. This will occur even though a borax flux is used. To use a deoxidizing substance with the silver would mean the formation of slag, permissible in melting silver for a casting, but annoying when forming shot. This absorbed oxygen is expelled on cooling. The result, in technical circles, is called "crabbing" or "spitting." Evidence of this phenomenon will be seen on the resulting fine-silver shot in the form of tiny spines or extrusions, extending outward in all directions. Pure gold does not behave in this manner. Sterling and gold alloys containing a large amount of silver show this tendency only to a slight extent. These extrusions on the surface of fine-silver shot are difficult to remove because of the difficulty in handling such small objects. The unevenness and irregularity of these extrusions make shot so distorted unusable for decorative purposes.

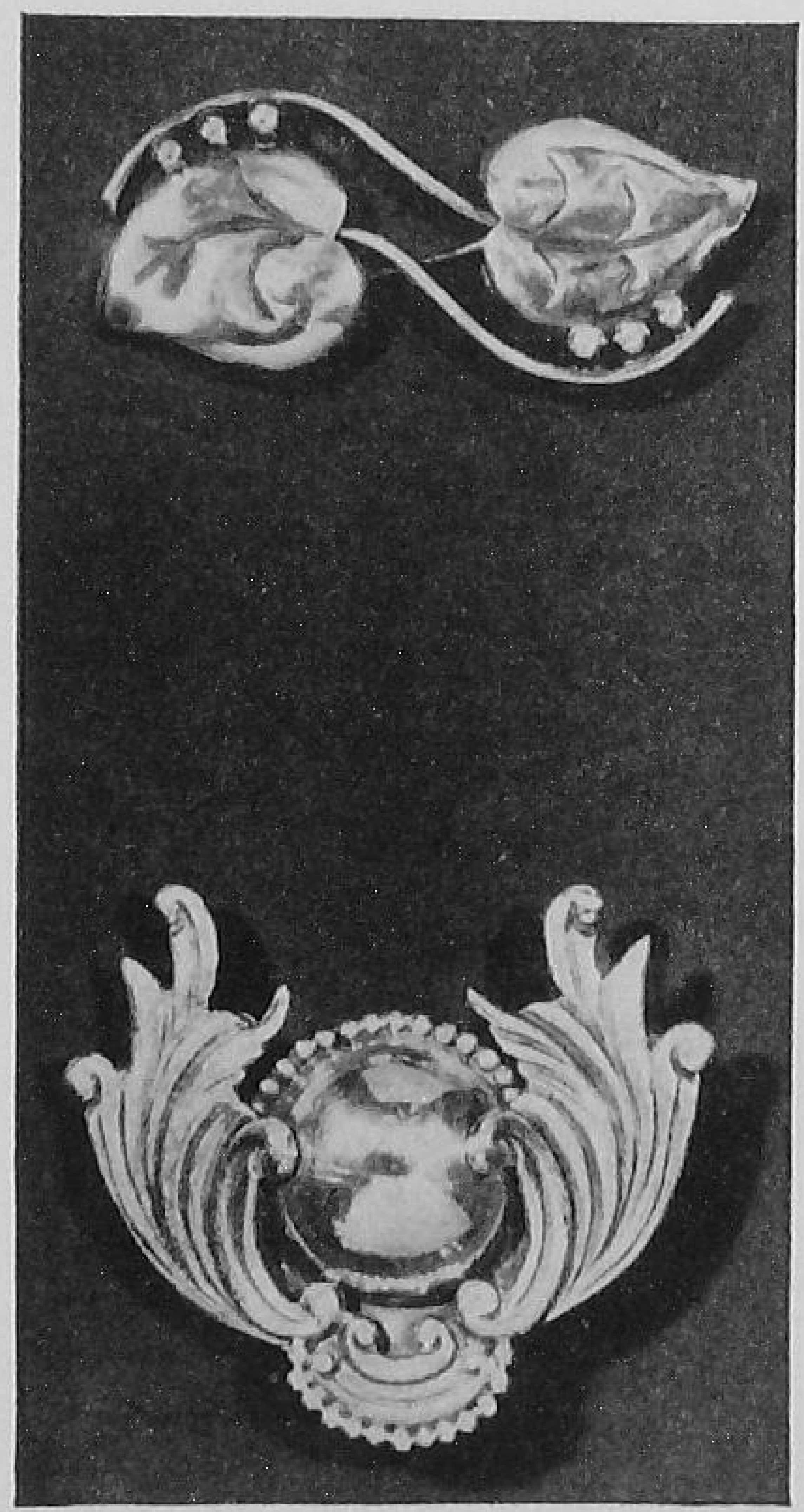


FIG. 27. (a) Simple repoussé leaves, with shot ornamentation; (b) use of dome and shot, with repoussé work.

Shot does not form in perfect spheres, so it is inadvisable to continually remelt in the hopes of obtaining such. However, the slightly flattened base makes it easy to set down each ball in place for soldering. Should the ball refuse to stay in position, it may be flattened on its base without harming its general shape as follows: Place the ball on the end grain of a piece of

hardwood, such as maple or birch, and tap once, lightly, with a flat hammer. The underside of the ball will remained unchanged.

One of the problems in forming shot concerns the duplication of one already formed. To insure matching shot to one already formed, the latter must be weighed on a balance scale. Enough metal to equal the weight of the finished shot will produce another one of equal size.

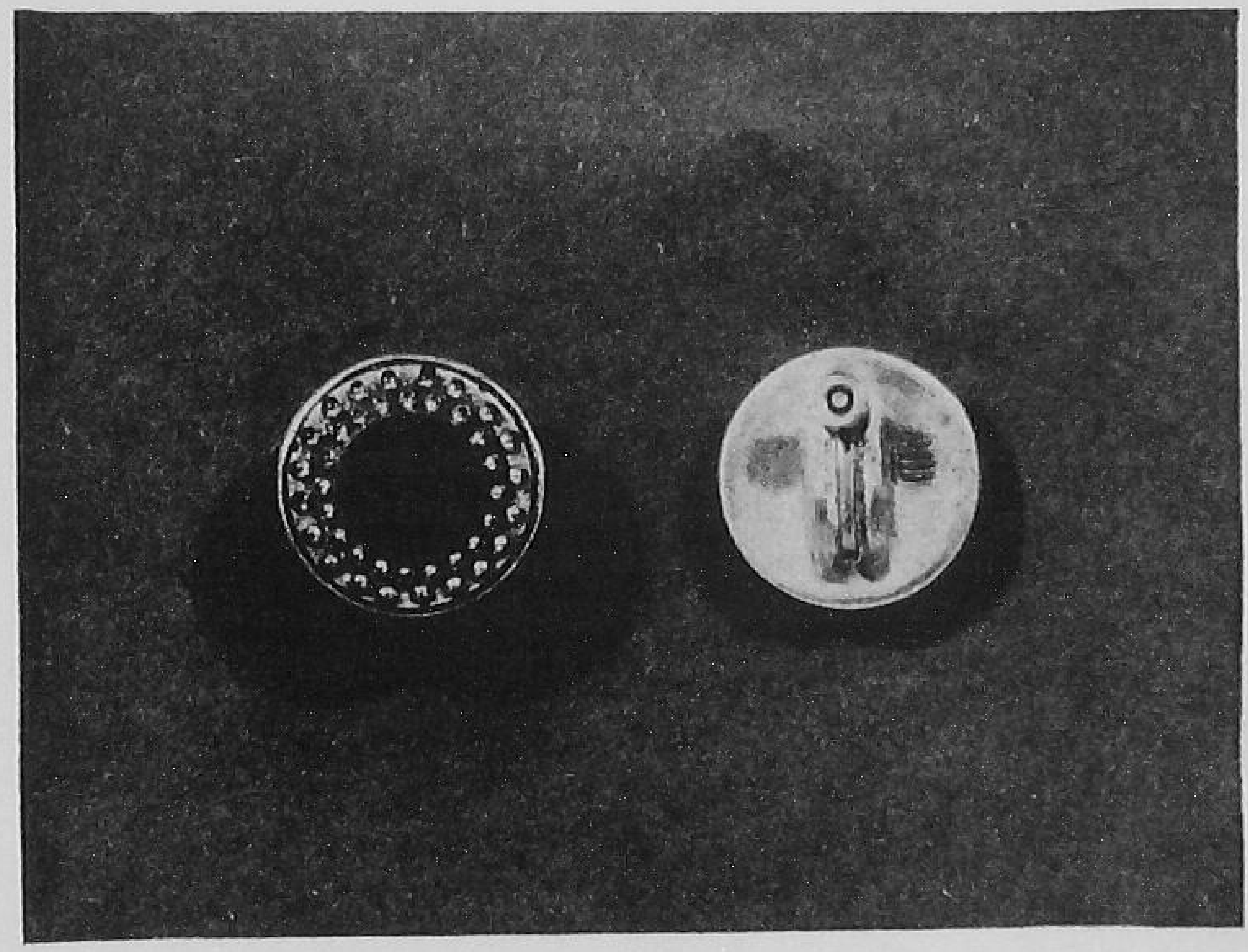


Fig. 28. Ear-rings. Cluster of shot around onyx.

However, when a quantity of shot is to be made up, all equal in size, the silver may be measured out in two ways. The first method is to measure off equal spaces on a piece of silver wire. These spaces may be marked off with a three-cornered jeweler's file. Cut these equal pieces, curl each up with a pliers, and melt each one of them. Equal-sized shot will result. It will be necessary to determine experimentally the proper length of wire necessary to make a ball of the required size. The craftsman who has frequent need of shot should make a table of shot sizes, listing the necessary length and weight of wire necessary for shot of a particular size. He may do this after deciding the gauge of wire he will use at all times for the shot.

Listing the weight is valuable when scrap metal is to be used for making shot. The necessary weight of scrap metal will be in the table.

The second method is similar to the method used for making links. The wire is closely wound around a metal rod. The coil is slit along its length with a jeweler's saw (see Fig. 78). It will then fall into separate rings. Each ring, when melted, will form a shot, and all will be equal in size. Here, too, it is necessary to determine wire and link size to obtain shot of a particular diameter.

If it is necessary to polish shot before it is applied as ornamentation, a "shellac stick" or "dop" may be used. For this purpose, a piece of 3/8″ diameter dowel, about 5″ or 6″ long, is secured. On one end of this rod, melt some stick shellac, obtainable in large paint shops. Another suitable cement is made by melting together equal parts of flake shellac and sealing wax. A candle may be used for melting the shellac as well as for heating prior to attaching the ball. With the ball partially imbedded in the shellac, the end of the shellac stick is then brought in contact with the polishing wheel. Commercially, quantities of shot are polished by tumbling them in a barrel, or mill, together with pebbles and fine abrasive. The mill is slowly rotated on a horizontal axis by a motor.

To conclude, an additional use for shot is its use as a basis for small discs. The finished shot is placed upon a polished steel plate and struck with a similarly polished flat hammer. Very few blows may be struck before it is necessary to anneal the flattened pellet. If the disc is not annealed, it will begin to crack around its edges. When this occurs, the disc will have to be discarded or remelted. This method of making small discs with slightly rounded edges makes available another means of decorating a surface by appliqué.

Domes.

Domes of metal are another form of ornamentation used by the jeweler. These domes are generally from 1/4″ to 1″ in size when used for jewelry purposes. Smaller domes may be made, although for such purposes shot is often substituted. Domes may be formed on the surface of the metal jewelry itself but a dome made separately and then applied to the work makes a finer appearance. Such domes are often the basis of a ring, or other piece of jewelry.

Domes may be made in several ways. A heavy nail rounded on one end may be used. The metal is rested on a lead block or the end grain of a close-grained hardwood, such as birch or maple. A blow of a hammer on

the nail, which rests on the proper location on the jewelry, will form a dome on the reverse side. A more permanent tool can be made of a piece of cylindrical tool steel, or drill rod, appropriately shaped, hardened, and tempered. (See chapter on chasing tools.) A dapping punch may be used for the same purpose. These are available in various sizes and can be bought in sets.

When a more perfect dome is desired on a piece of flat jewelry without resorting to an applied dome, the dapping die is useful. This is a steel cube, having its six faces covered with a variety of circular hollows of varying sizes. This die is used in conjunction with dapping punches and dapping cutters or hollow punches. For self-doming jewelry, the cutters are not used. The piece of jewelry is placed over the desired hollow, properly located, and a punch of the required size is placed over the metal. The punch is then given a few careful blows of a hammer until the dome is formed on the reverse side. Then, keeping the dome in the hollow, a moderate blow with a flat hammer over the back of the domed area will insure a dome in sharp relief. When this work is done there is danger of cutting through the work at the edges of the hollow. This is avoided by several means. First, a punch should be selected slightly smaller than the hollow in the die. Thus, allowance is made for the thickness of the metal. If possible, the metal is annealed before forming the dome. Lastly, the beginner should attempt a few practice domes.

There is often difficulty in placing the area to be domed on its proper hollow, so that the dapping punch may be properly centered and the dome properly located. If the jewelry is smaller than the die itself, an excellent method may be used, which is shown in Fig. 29. The lines on the die shown in the photograph are drawn by using a scriber on the face of the die, making permanent center lines across the hollows, at right angles to each other. The pencil lines on the jewelry are at right angles, and through the center of the area to be domed. The pencil lines and scribed lines are brought into alignment.

Dapping punches are usually numbered on the shank. If a set of steel numeral dies are available, the hollows on the dapping die may be identified by stamping a numeral alongside the hollow, to correspond with the punch size. Allowance for the thickness of metal should be made before fitting the punch.

To make separate domes, for application to the jewelry by soldering, a metal disc of the proper size must first be made. Metal discs may be made, of course, by scribing the proper circle with a pair of dividers and

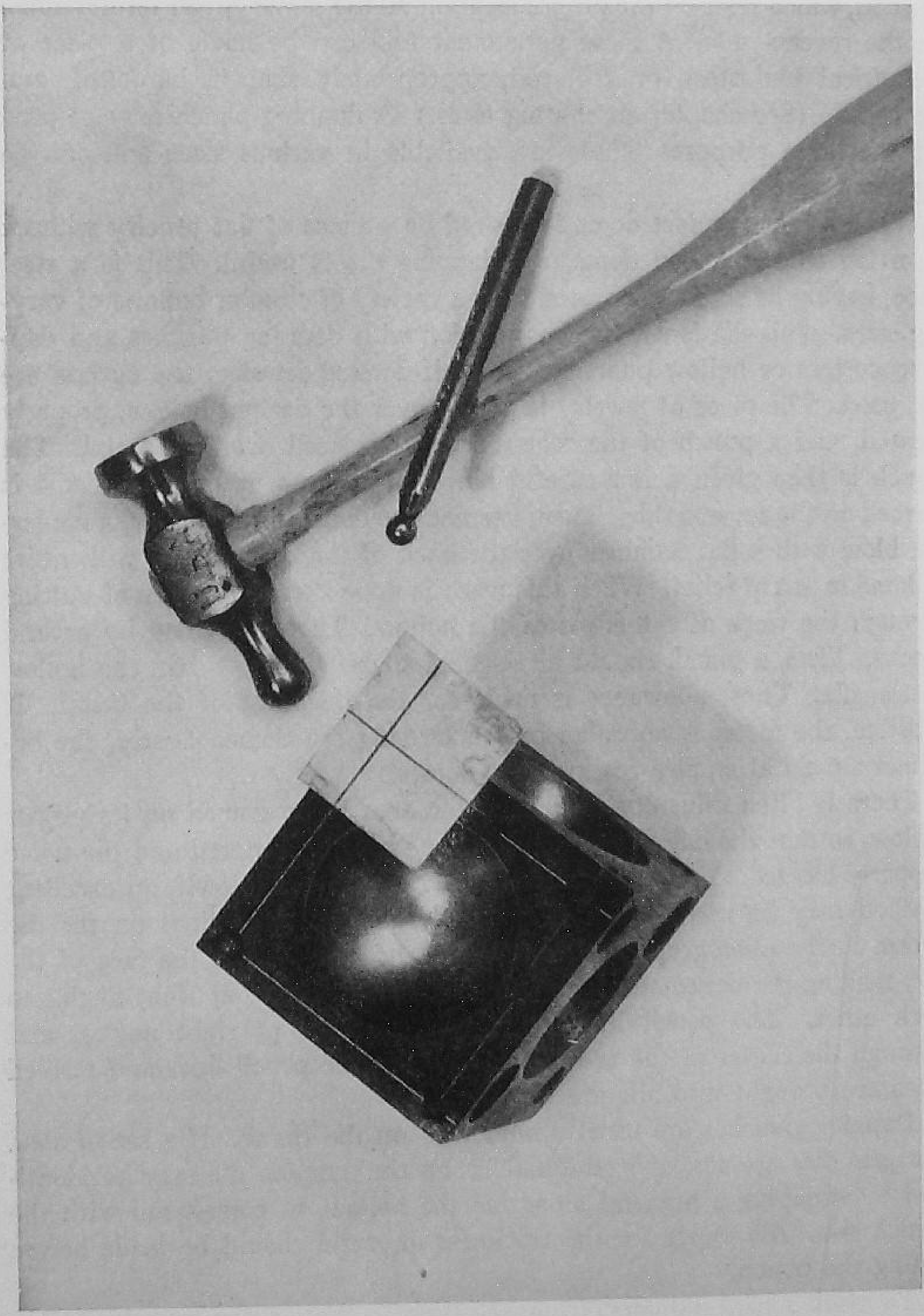


Fig. 29. Set-up of work for doming at a precise location.

then sawing. However, a much more satisfactory method employs the hollow punch or dapping cutter. Good dapping cutters are made of tool steel rod, with one end hollowed out. The edge around this concave portion is sharpened. Such cutters are used on thin metal, up to No. 24 gauge, and come in sizes from about 3⁄16″ to about 5⁄8″. To use the cutter, place the metal, preferably annealed, over a lead block. Hold the cutter in position, perfectly upright, and strike the solid end a strong blow with the flat of a ball peen hammer. One or two blows should dislodge a disc. The resulting discs are slightly cupped because the greatest pressure exists at the cutting edge or circumference of the disc. The cupped disc is placed on an appropriate hollow in the dapping die, the proper punch is centered over the disc, and the disc domed out. To make the dome somewhat deeper, it may be placed in the next smaller hollow and hammered further.

The hollow punch consists of a collar of steel mounted on a steel shank. The collar of steel is sharpened at its cutting edge. Such punches are made in small sizes and also in large sizes, over 2″ in diameter. They are used in the same fashion as the dapping cutter. In both cases, the end grain of a block of hardwood may substitute for a lead block, although the lead is preferable.

Hollow punches also are obtainable in squares, oblongs and special shapes from die-makers or large hardware dealers. These are quite expensive, however, and their purchase is justified only when frequent production of an item is contemplated.

When large domes are to be made—1″ and over—a suitable hammer may be used for doming out the disc. The largest available hollow on the dapping die may be selected, and a hammer chosen with its striking surface of suitable curvature, so as to fit the curve of the hollow. A disc of the proper size is cut by punch or saw, and carefully hammered to shape in the dapping die. It may be necessary to anneal the metal during this process. A substitute for the dapping die is the pitch bowl. The circular metal piece is imbedded in pitch (see chapter on *Repoussé*), and a silversmith's hammer, or an embossing hammer of proper size is used to dome out the disc.

Domes are generally made from metal ranging in thickness from No. 22 to No. 28 gauge. The lighter weight metal is used for domes as small as 3⁄16″. The No. 22 gauge will do for domes about 1⁄2″ to 5⁄8″ in diameter. For intermediate dome sizes, use the No. 24 or No. 26 gauge. Domes

larger than ¾″ may be made of metal from No. 22 to No. 18 gauge in thickness.

Leveling Domes.

Domes may be leveled at the base by placing a sheet of abrasive cloth, with the abrasive side up, on a piece of plate glass or a surface plate. The dome is drawn across it in long, level strokes. Domes may be made to fit a curved surface by placing abrasive cloth over a suitable curve or on the jewelry itself, and rubbing the base of the dome on this surface until a good fit is obtained.

For instructions on soldering domes, either as appliqué or to form spheres, see the chapter in this book on "Hard-Soldering," and look under *Specific Hard-Soldering Jobs.*

Chapter X

CHASING AND REPOUSSÉ, WITH A NOTE ON TOOL MAKING

Chasing and repoussé are almost synonymous terms. They are methods of decoration similar in some respects to shallow sculpture in metal. They are the means of bringing a design out of a metal surface, into low, or bas-relief. They are the means of producing from a flat sheet of metal a three-dimensional result (Fig. 41).

Actually, repoussé is the French term for chasing, but although the two words are used synonymously, there is a technical distinction between the two: chasing, while covering the field of repoussé, or modeling in metal, also includes the technique of enriching a metal surface by the cutting of lines to form a surface decoration. Thus, a chased ornament is frequently one which has *no modeling or raising of the surface* but only intricate design cut into the surface. The term "repoussé" would not apply to such ornamentation, yet an article decorated in repoussé might correctly be described as "chased." The term "chasing," then, is really the *all-inclusive* title, and when *specific* reference *to modeled or bas-relief effects is to be made,* the term "repoussé" will be employed in this book.

The Tools.

The tools used for chasing are the chaser's pitch bowl; the chasing hammer; and a set of small, polished, punch-like tools or chisels called, simply, "chasing tools" (Fig. 30).

The chasing tools are many and various in shape. They are sometimes classified into groups, which help describe their function. Such groups are the *liners* or *tracers,* the *raising tools, planishing tools, matting tools,* and so on. The beginner needs only a few tools to start. In the actual description of the technique, reference will be made to the individual tools and their functions.

The chasing hammer with its characteristically shaped head is available in various weights, from about 1 ounce to 6 ounces. The 4- and 6-ounce sizes are more commonly used. The handle of this hammer is generally

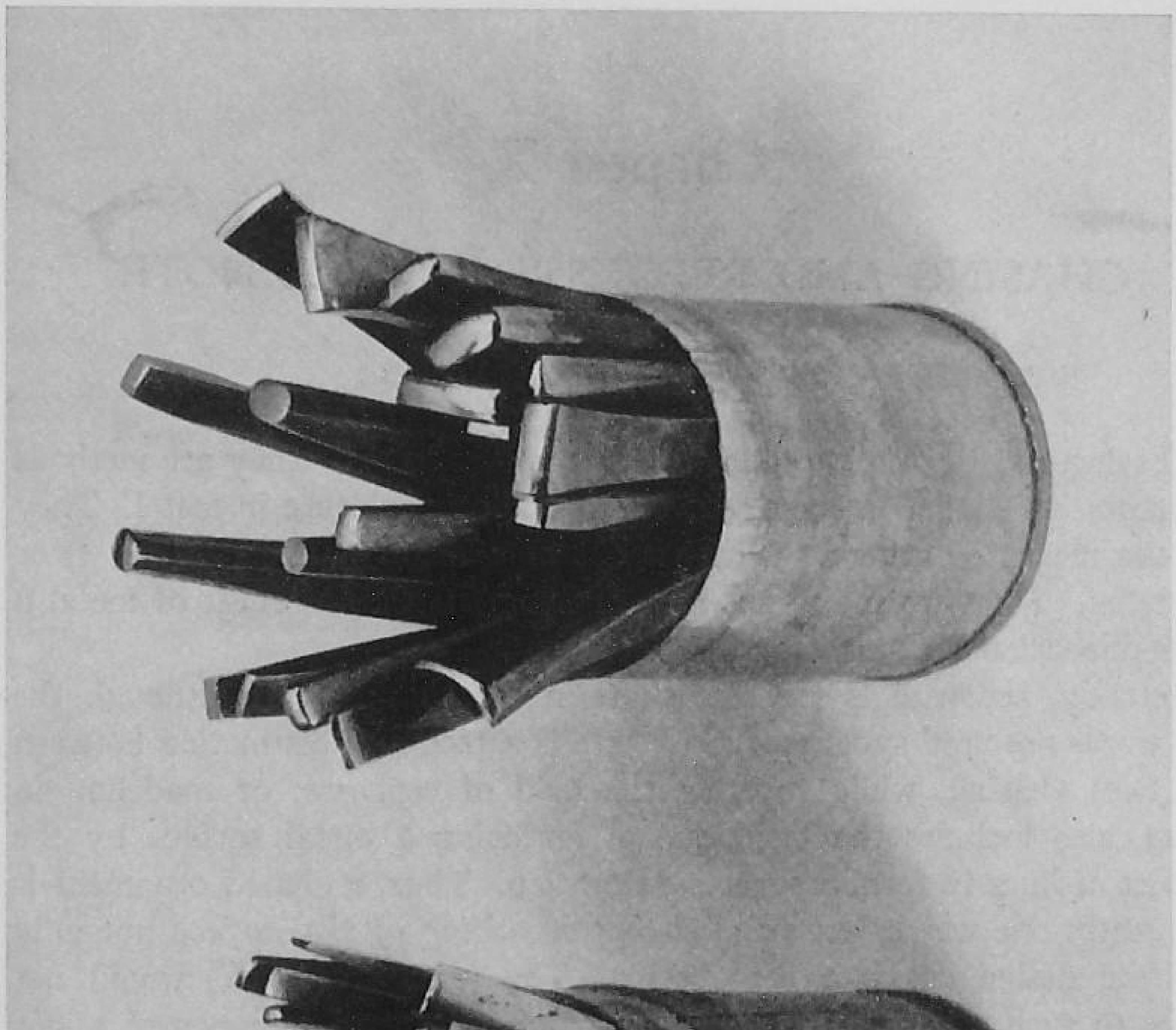


FIG. 30. A group of chasing tools, including a matting tool. (Center left-hand container.)

oval- or pear-shaped at the grip, and tapers to a rather narrow diameter along the major portion of the shaft. This allows for a comfortable grip in the palm of the hand and a "springiness," or resiliency, in the blow of the hammer.

The pitch bowl, or pitch pan, is a container large enough in surface area to permit the work to be comfortably anchored in the pitch. It is also helpful if the area is large enough to permit the side of the hand to rest close to the work. The pitch bowl, which is a hemisphere of iron, filled with chaser's pitch, is useful, as it may be tilted at various angles on certain occasions. The bowl is supported on a leather ring or a leather collar which permits the tilting (Fig. 33). The leather collar may be made of leather belting, 2″ in width, formed to a circle, or collar, with the ends riveted together. The pitch pan may very well be a baking tin, at least 1½″ in depth. This tin is filled with chaser's pitch and is used in conjunction with a flat sand-bag, upon which the tin should be rested for best results.

The chaser's pitch is an amalgam formulated so that when its surface is warmed, it will hold a piece of metal securely and yet allow the metal to be worked into its surface at whatever points desirable. A heavy sheet of lead is sometimes substituted for the pitch bowl when the shaping or modeling to be done is minor in character. Formulas for chaser's pitch amalgams are discussed at the end of this chapter.

The Process.

A brief, simple explanation of the process of chasing will now be given which will be followed by an elaboration of each step in detail:

The metal bearing the design to be chased is imbedded in chaser's pitch. The liner or tracer is then worked over the outline. The metal is now removed from the chaser's pitch. On the reverse side should be seen a raised line indicating the outlines of the design. The metal is again imbedded in the pitch, this time with the raised outline up. The proper, rounded, raising tools are now used to work out the inside portion of the design, so that it will appear in relief on the other side of the metal. When this is done, the metal is again reversed in the pitch, and the design, which is now in repoussé, is given the finishing touches with the proper chasing tools (see Fig. 34).

And now for the details:

A design may be placed upon the metal using a suitable technique, as discussed in the chapter on the transfer of designs. The metal may be

imbedded in the pitch by gently warming the top surface of the pitch with a gentle, blue flame from the torch. A yellow flame will deposit carbon over the pitch and make it messy to work with. An intense flame will burn the pitch, rendering it useless. The pitch should be heated so that the metal can be pressed into its surface, but not to an extent where the metal tends to sink under the surface. The metal should be placed somewhat toward the upper right for a right-handed craftsman. Some pitch may be pushed so as to slightly overlap the edges of the metal. Sometimes a worker rests the metal on the pitch and heats the two together. This is permissible if the method of transfer used will not suffer by the application of the flame. Do not "cook" the pitch bowl *over a flame,* in preparing for repoussé work. The pitch should be soft enough, at the time chasing is done, for it to take the impression of a finger pushed *firmly* into its surface.

Sometimes a worker will coat the back of his work with a thin coating of oil or vaseline. This makes the removal of the work somewhat easier. However, the continual use of oily substances will result in a fouled pitch bowl, which will not only be unpleasant to work with but which will not properly hold the metal after a period. To remove work without the use of oil, the pitch bowl and work may be left to cool or may be chilled with cold water, either directly or with a wet cloth. The work may then be pried off the pitch with a tracing tool. It will usually part cleanly.

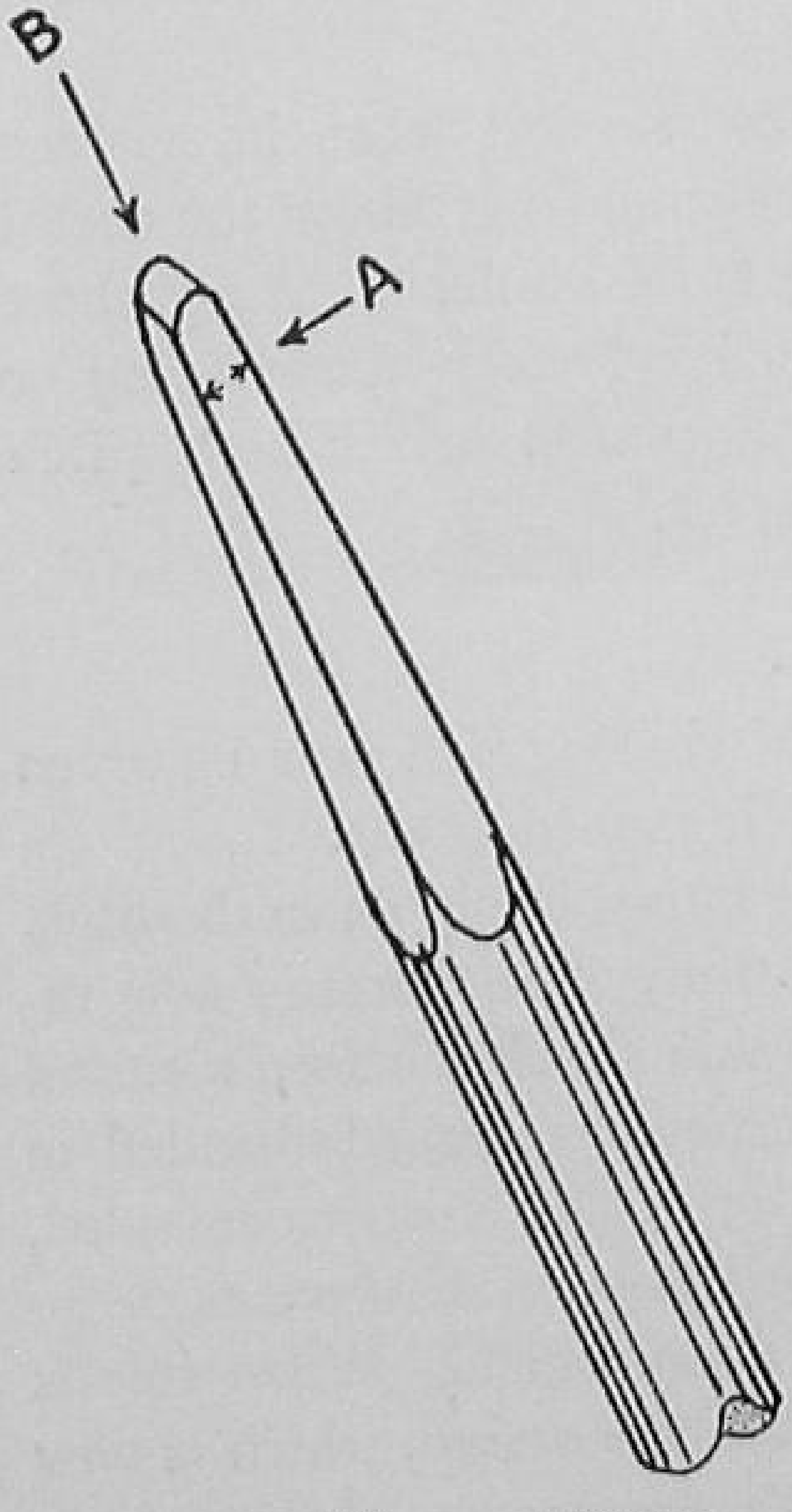


FIG. 31. Liner, or tracer.

Should pitch adhere to the surface of the work, it may be removed by soaking a piece of steel wool in turpentine and using it to rub off the pitch. To prevent a soiled work table, cover the table with a few thicknesses of newspaper.

The liner, or tracer, is now selected. This is a somewhat chisel-shaped tool (see Fig. 31). The width at *A* may vary from about $\frac{1}{8}''$ to $\frac{1}{4}''$, depending on the intricacy of the design. Note the curvature at *B*. This enables the chisel to progress along a curved path without leaving a jagged line. Very sharp curves require a narrow-width tracer.

The right-handed worker holds this tool in the left hand as shown in Figs. 32-33. The first three fingers of the hand are spaced along the length of the shank, with the third finger in contact with the end of the tool as well as the work. The thumb clamps the tracer against the three fingers, and also rolls the tool as it maneuvers around a curve. The little finger

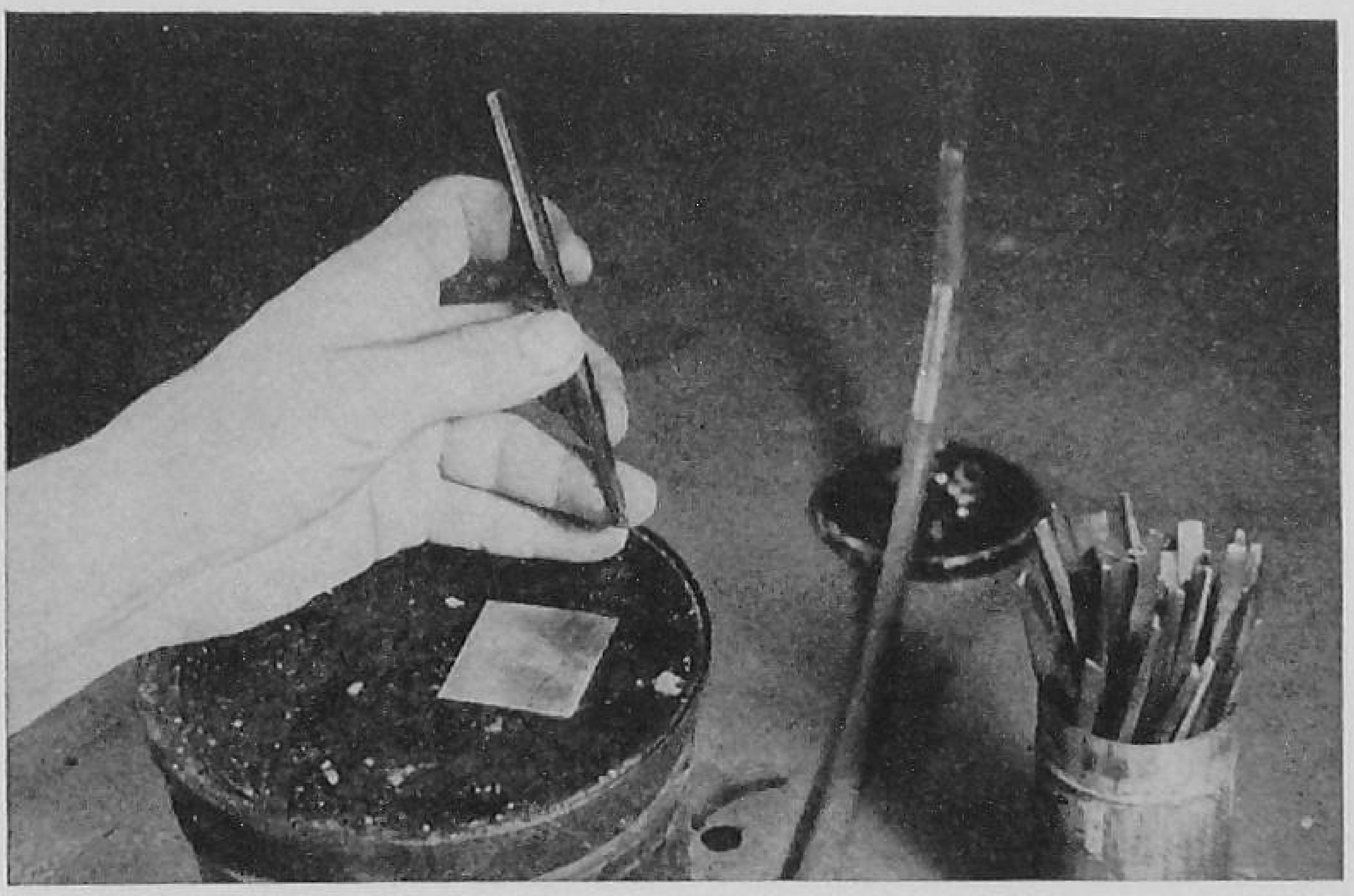


FIG. 32. Holding the chasing tool in its position in the hand.

rests, together with the side of the hand, on the space left on the pitch alongside the work. It will be found that the portion of the hand holding the tracer can move about an inch without actually moving the side of the hand. This is done largely by utilizing the side of the little finger as the pivotal point. Thus, about an inch of work can be traced without shifting the position of the hand.

The tracer travels in a direction *toward* the worker. The chisel is carefully tilted back a few degrees so that the top of the tool is farther from the worker than the point. This makes it possible for the tool to travel along its path (toward the worker) in a very gradual manner, leaving a smoothly indented line. If the angle is *too great,* the tool will "skitter" over the surface without cutting a proper line. When a sharp curve is encountered, the slight angle at which the tracer is being held is increased and the tool works its way around a curve almost "on its heel."

The chasing hammer is held so that the pear-shaped portion of the handle is in the palm of the right hand. It is important that when the face of the hammer contacts the top of the tool, the hammer handle should be at right angles to the shank of the tool. The hammer is used in a succession of rapid blows, *from the wrist*, with just enough force to leave an

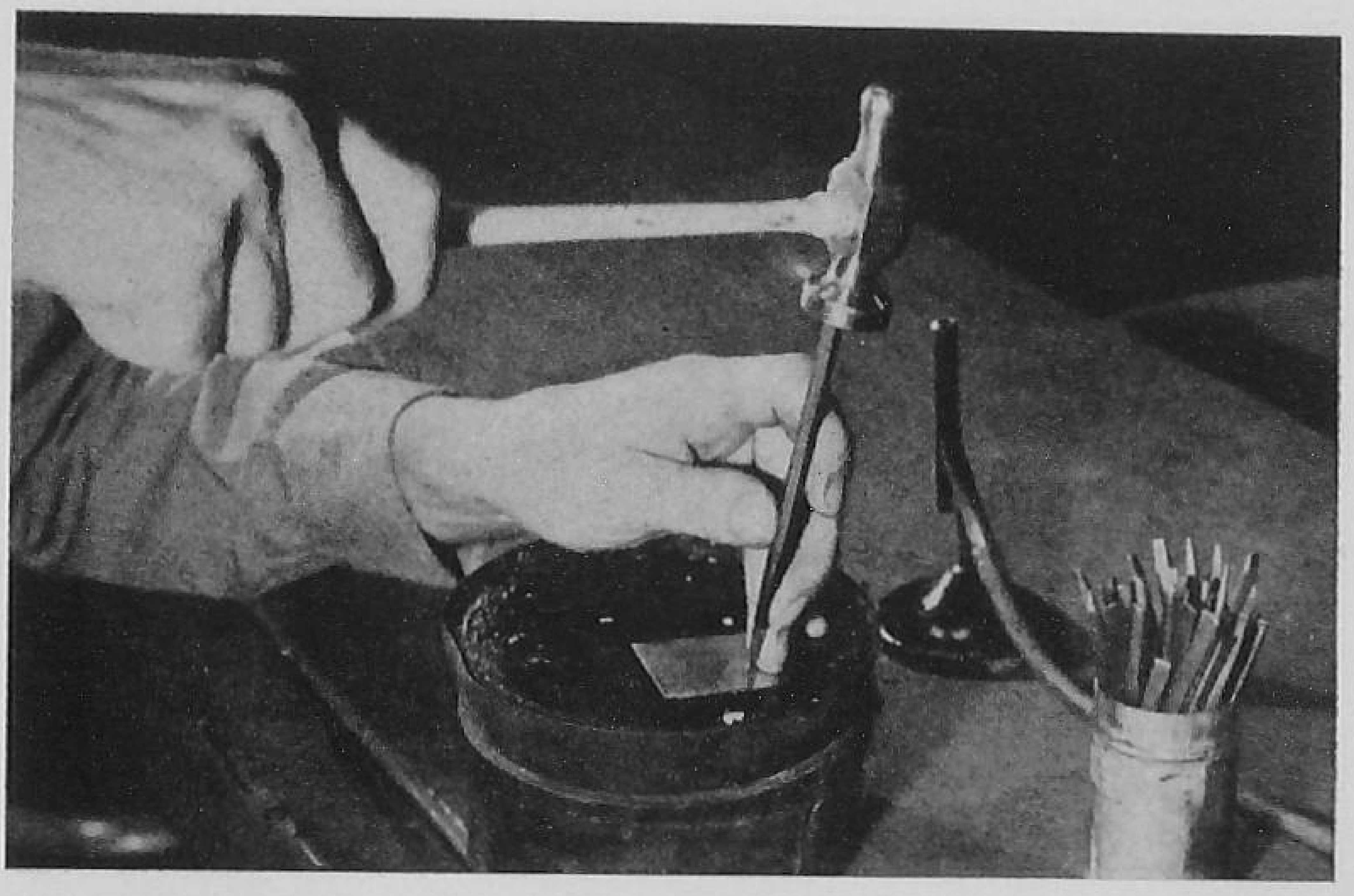


FIG. 33. Holding the chasing tool in its position on the work.

indented line. The progress of the tracer should be almost unnoticeable to get a clean line. If the tracer does not seem to move at all, the cause lies either in a dirty work surface, which retards the sliding, or a vertically held tracer. Either will result in eventually cutting a hole through the metal. It must be remembered that during all chasing, the surface of the metal being worked upon must be perfectly clean.

This chasing operation is not only the first step in a repoussé job, but is also a process used to cut lines on a piece of work that is to have no further chasing operations. In other words, when it is necessary to cut a line on a job, to fulfill some part of the design, this "tracing" is the method used.

The importance of perfecting this technique cannot be overestimated. It requires practice. Some require only a short session to master most of its difficulties. Others require hours. Chasing on a piece of jewelry should

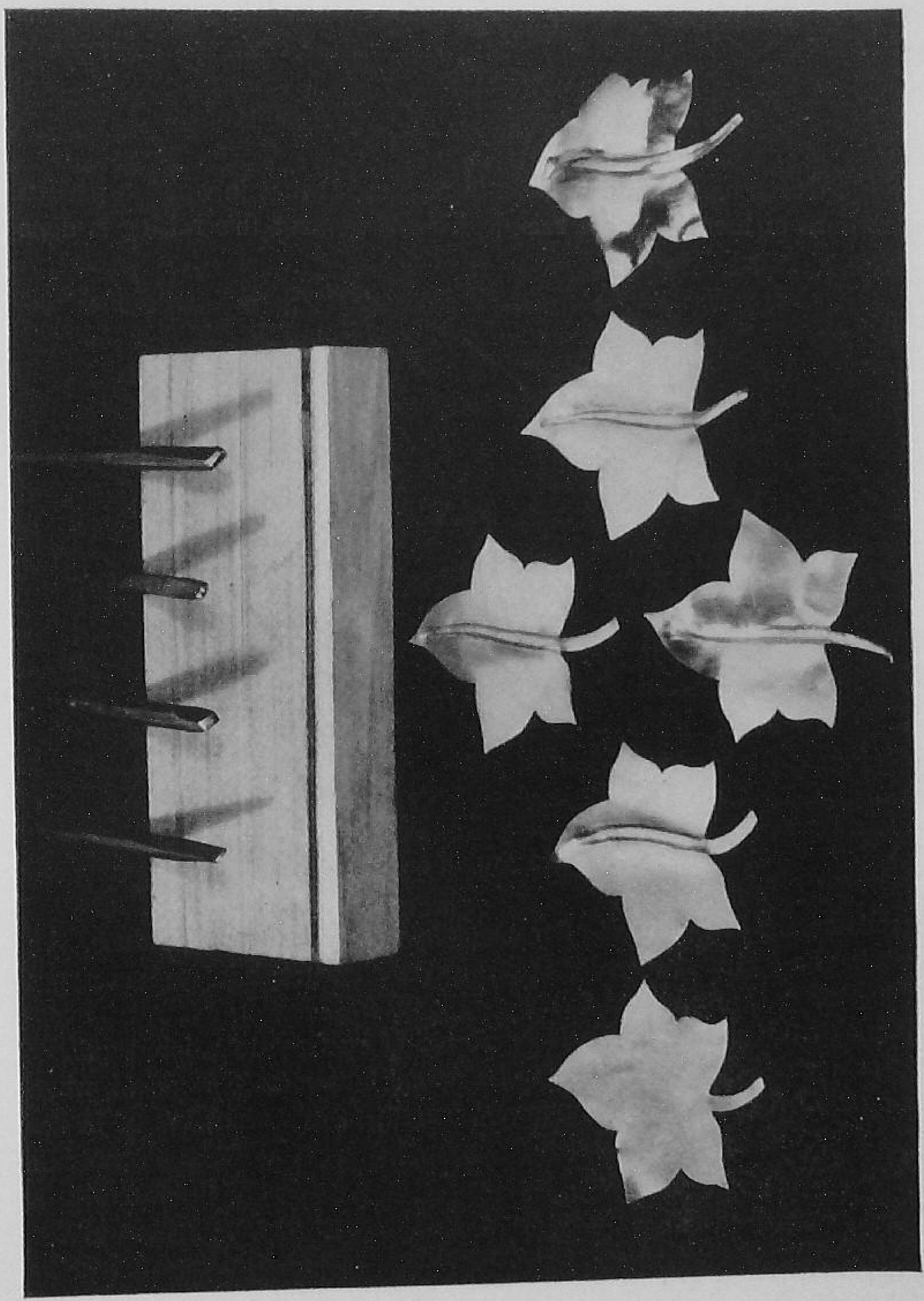


FIG. 34. A veined leaf in various stages of construction, and the chasing tools involved in this job.

not be attempted until good results can be obtained in practice. When this first tracing technique has been perfected, the craftsman is ready to continue with the next step in repoussé.

Raising.

Work that is designed to be done in repoussé is that in which a portion or portions of the design are raised. To what extent this raising is done

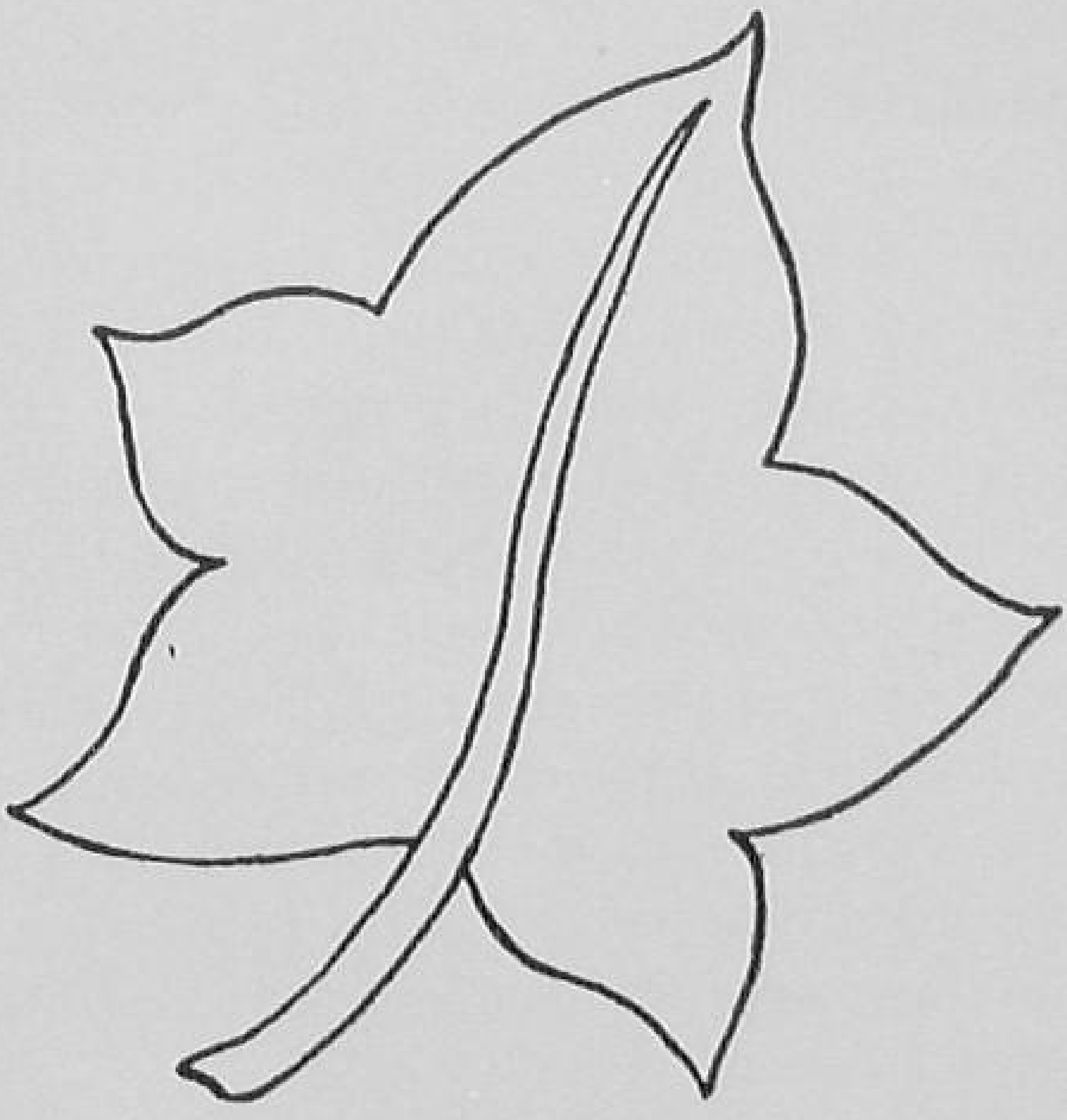


Fig. 35. Full-size pattern for veined leaf.

depends on the design itself. For example, an ivy leaf may be done. An example of a leaf in repoussé is shown in the photograph in various stages of completion (Figs. 34 and 35).

Work of this nature is relatively simple in contrast to a job requiring the working out of a human face in full detail in repoussé. The leaf, when tracing has been completed, is removed from the pitch and reversed in the pitch bowl. It will be necessary to clean this "reverse" side thoroughly with turpentine and steel wool. The raised lines, outlining the leaf with a central vein, are visible. It now remains to hammer *in* the portions of the leaf between the raised lines. Thus, when the leaf is again reversed to its original position, it will be convex in its general surface appearance.

This "raising" will require the use of chasing tools having rounded ends, in various degrees of convexity.

A leaf as large as 2″ might even be raised by the careful use of one or more of the many polished silversmith's hammers ordinarily used for forming bowls and other hollow objects (Fig. 47). The convex-ended tool, whatever it may be, must be chosen not only for its size but—perhaps even more important—for the arc of its convexity. The shape of the tool must approximate the desired curve of the raised object as nearly as possible.

When chasing tools are used, they may be held and used in the same manner as the tracer, with this one difference: the tool should be held at right angles to the point on the curve at which it makes contact during raising. This means the angle at which it appears in the worker's hand will vary at different places on the work. Also, the blow of the hammer may vary in weight at different points to produce a gradual curvature or varied depth. The important thing to remember, as far as end result is concerned, is that a curved section in repoussé should give the appearance of a perfect, smooth curve, unmarred by small protuberances or "bumps" caused by using tools with sharply curved faces.

The work is next removed from the pitch, as previously described, and freed of any adhering pitch. If the raised surface is now cleaned with fine steel wool, any imperfections on the surface will be easily seen. These imperfections may usually be corrected by returning the object to the pitch bowl and working over the concave surface, at the proper points, until a smooth surface results.

When it is desirable to correct any errors in shaping by working over the raised, or convex, surface, the work is imbedded in the pitch with this surface up. The hollow portion on the underside must be filled with pitch to avoid collapsing the curve. Test for hollowness by tapping lightly with the tool at different points. Gently heating the work as it lays in the pitch will frequently cause small hollows on the underside to fill in with pitch.

With the raised surface now facing the worker, any necessary work that is required for shaping may be done. Tools must be carefully selected. In the case of intricate jobs, the many odd-shaped tools available for repoussé work may be called into use. This final shaping is necessary in complex work to give sharpness and detail to a finished ornament. Remember to anneal the work occasionally to make it more "workable."

The finished ornament, at this point, may be cut out with the jeweler's saw. This is done when the ornament is to be applied or is a single ornamental piece in itself. (Sometimes, on the other hand, an ornamental area in repoussé is worked out of the metal comprising the actual piece of

FIG. 37. Repoussé work in various stages of completion. Despite the relative intricacy, these pieces are successfully managed by young pupils with only a little prior training.

jewelry, as a series of repoussé designs along the surface of a bracelet.) There is good reason to saw out the ornament *after* it has been worked in repoussé. As an example, the cherub in Figs. 36-37 might have been cut out with a saw and *then* worked in repoussé, saving the tracing of the outline. This is inadvisable, however, as the metal around the outline is of inestimable aid in keeping the work properly positioned in the pitch bowl during repoussé work. The result of leaving this metal until the work is completely formed will be a much better repoussé job, more easily obtained.

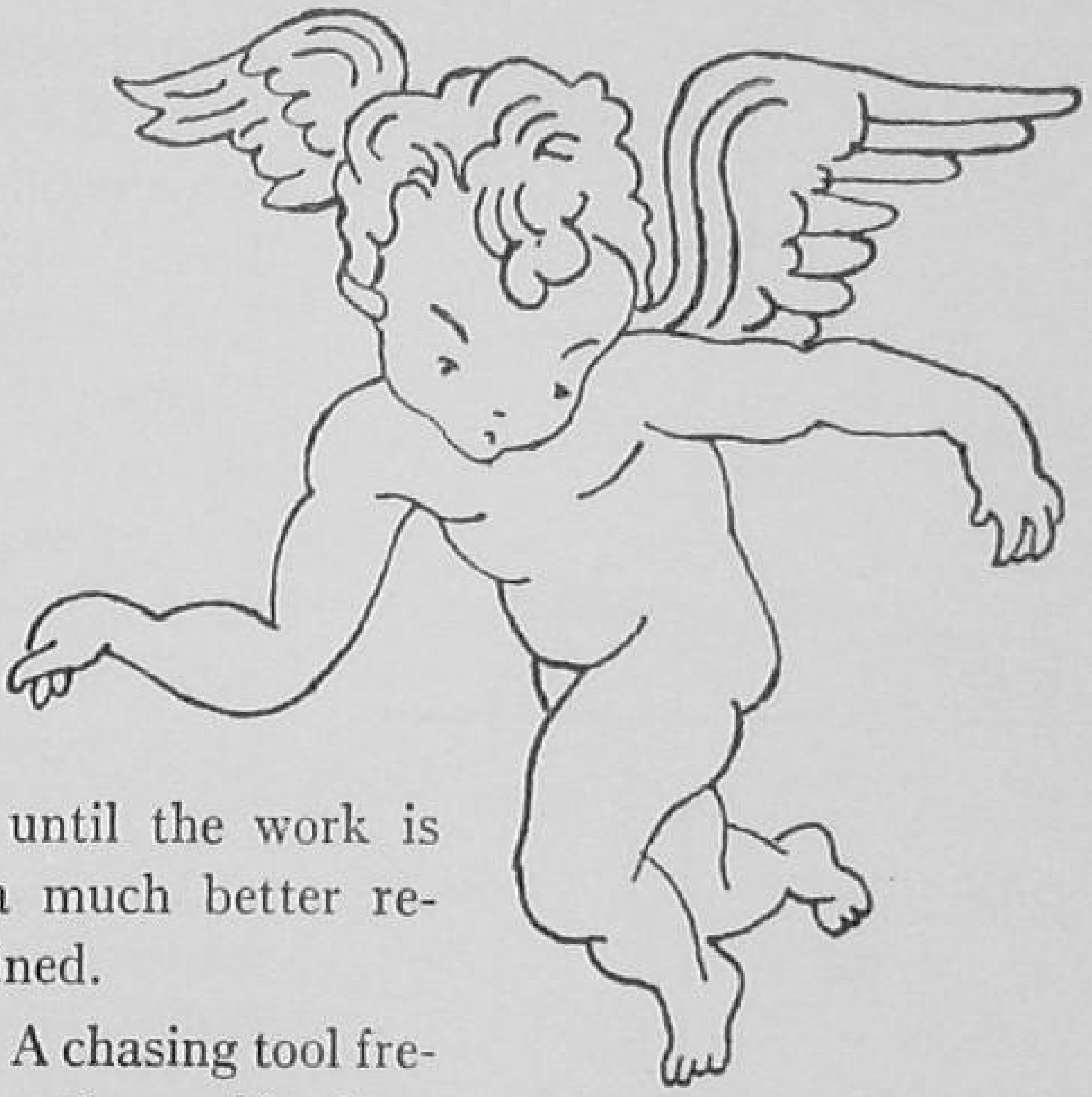


Fig. 36.

A chasing tool frequently used in chasing or repoussé is that pictured in Fig. 38 (No. 2 in Fig. 34). This tool is available, or can be made to the following dimension: width at *B* from 3/64″ to 1/8″. Width at *C* from 1/8″ to 3/16″. Surface *A* slopes at an angle of 4 or 5 degrees. Its curvature is slight, similar to a tracer or liner.

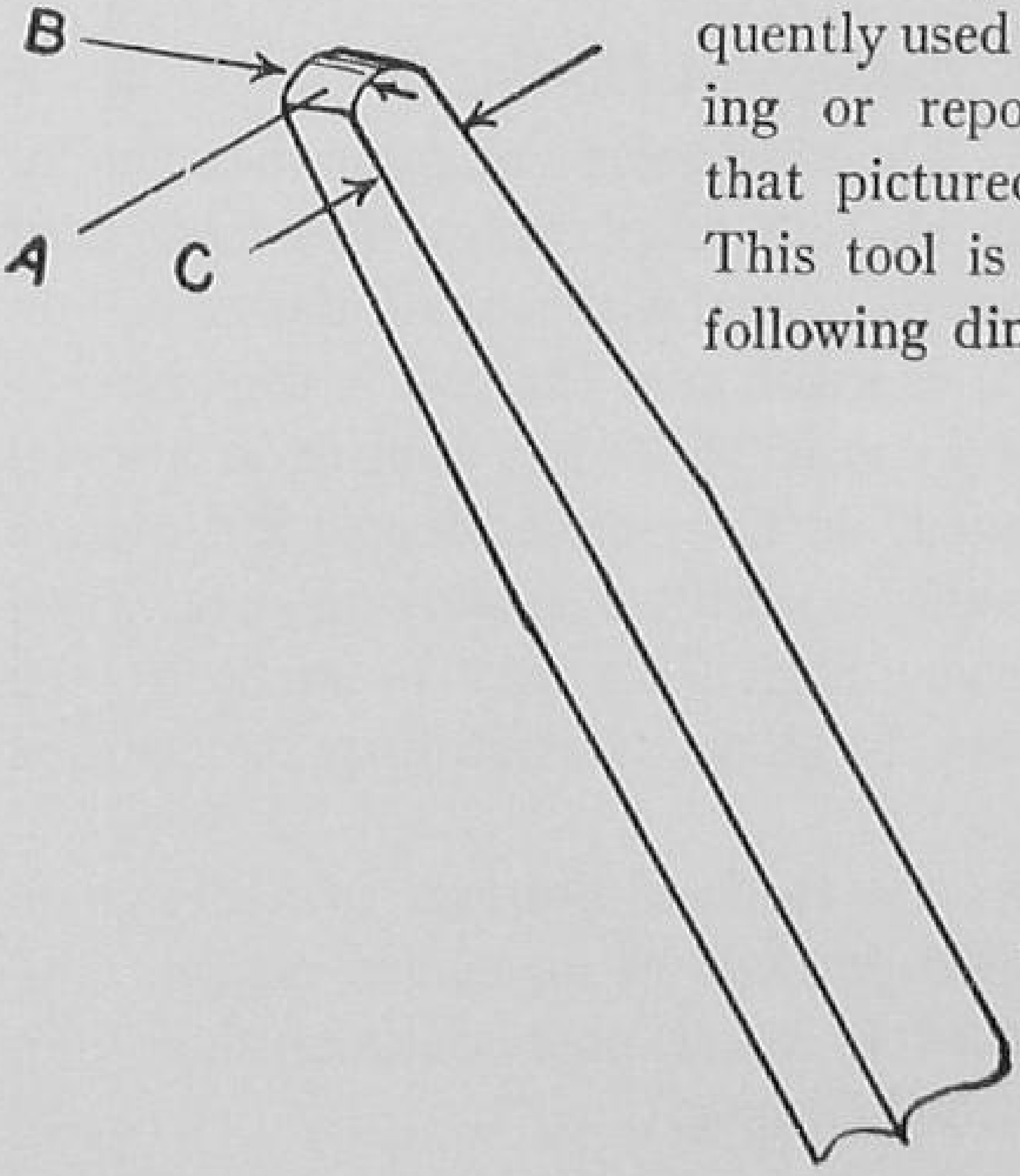


Fig. 38.

This tool is frequently used after the tracer. Properly used, it does away with the appearance of an indented line, and gives a sloping surface at the line, when this is desirable. Its effect is shown in Fig. 34 on the last leaf, where a line is made first with the liner, or tracer, and then followed with the tool just described. Compare the effect with the previous chased lines.

Fig. 39 shows the change at surface *A* when this tool (which might best

be referred to as a "beveled chasing tool") follows the use of the tracer. Surface *A* slopes away smoothly, leaving surface *B* in sharp relief. The tool should be on hand in a few sizes, and the size chosen for use should be in proportion to the size of the work being done. The tool is handled in the same manner as a tracer, and it is positioned on the indented lines as shown in the accompanying diagram.

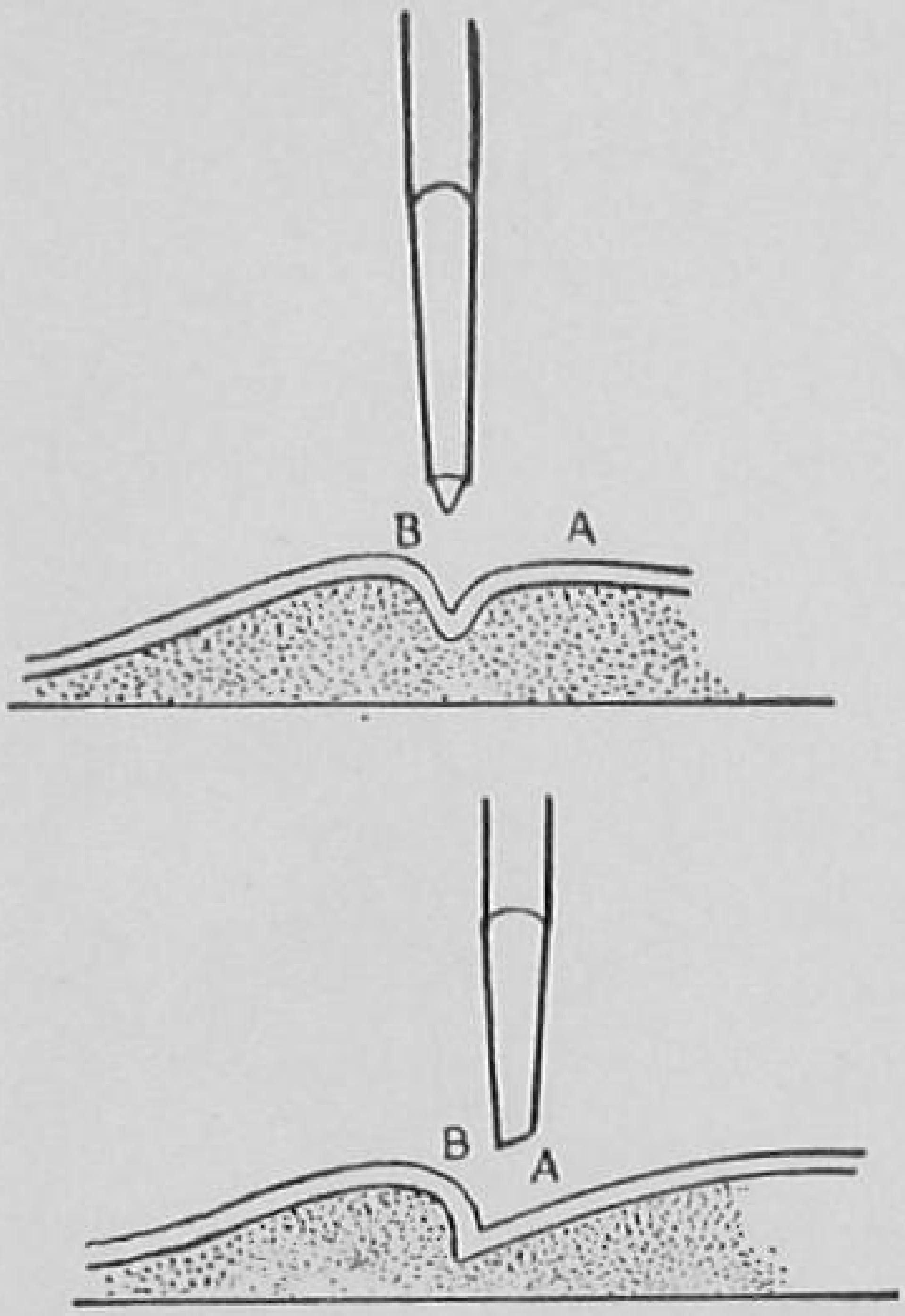


Fig. 39.

Other chasing tools that may be found useful are:

1. A narrow rounded tool, in appearance almost a rounded tracer. This is available in a few thicknesses and is useful to raise a band between two traced lines.

2. A rounded, pear-shaped tool useful for working in oval hollows that end rather pointedly.

Stamping and Matting Tools.

Stamping tools are somewhat similar to chasing tools except that their ends are decorated with a small design or unit of a design. The design may be flat, in which case the tool is used in conjunction with a small hammer in order to leave its flat imprint in a metal surface. When the design is rounded, or three-dimensional, it leaves a small unit *en repoussé*. Fig. 42 shows the result of employing such a tool having a heart as a unit for a design. Such tools may be made by the craftsman by using small files to form the shape and polishing the finished punch.

Matting tools are utilized to decorate recessed portions of a design in repoussé and, frequently, the recessed portions of an etched design. Unfortunately, they are sometimes used to cover poor workmanship, particularly in flat-chased work and etched designs.

Forming, Hardening, and Tempering Chasing and Similar Tools.

It is not difficult for the craftsman to make his own chasing, matting, and stamping tools. The material used is tool steel, a steel with a suitable carbon content to form good tools capable of being hardened and tempered.

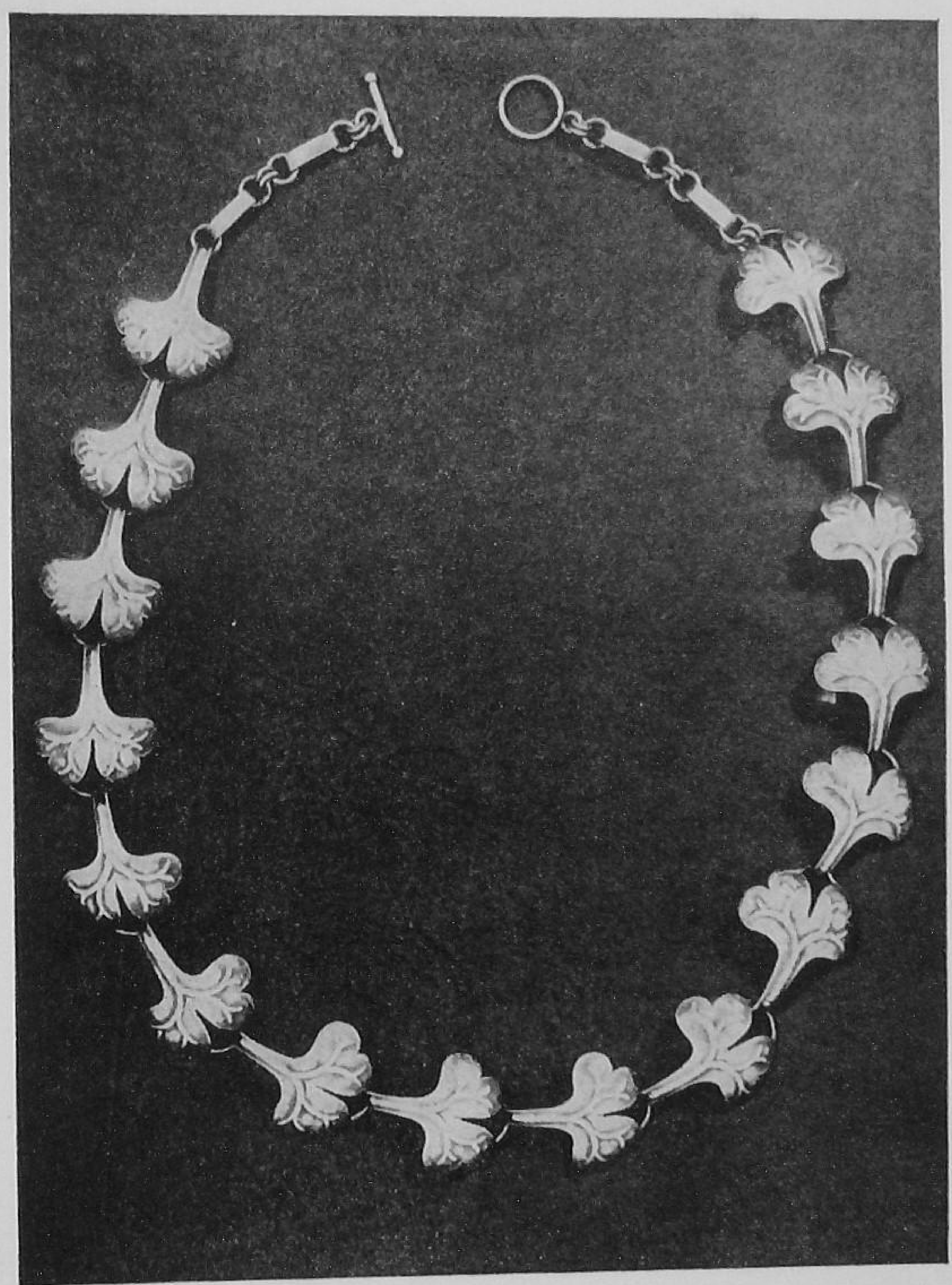


Fig. 40. A linked necklace showing veining resulting from the use of a "tracer" on the reverse side of the metal. (*Courtesy Anna Halasi.*)

Drill rod may be used, although for chasing tools hexagonal steel lengths are most suitable. This material makes up into an easily manipulated tool. Square stock may also be used. Old fencing foils yield sufficient

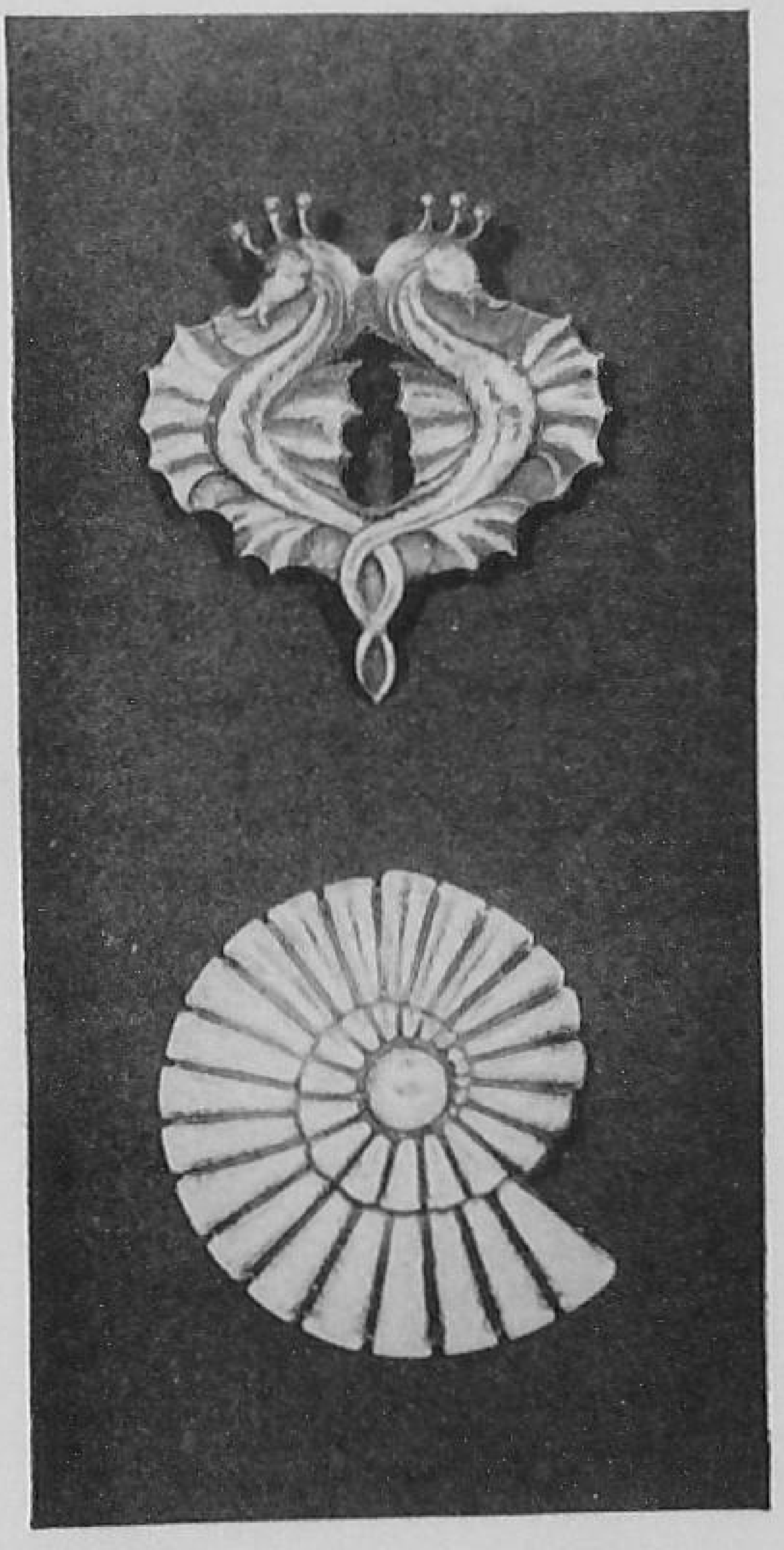


FIG. 41. Some articles of jewelry in repoussé. (*Courtesy Anna Halasi.*)

material for six or seven tools of varying cross-sectional areas. Thus, a relatively heavy raising tool can be made of the material near the hilt, while a fine tracer can be made from the material nearer the button end of the foil.

The first step in making a tool is the annealing of the steel. If tool steel is purchased already annealed, or soft, this process is eliminated, but if

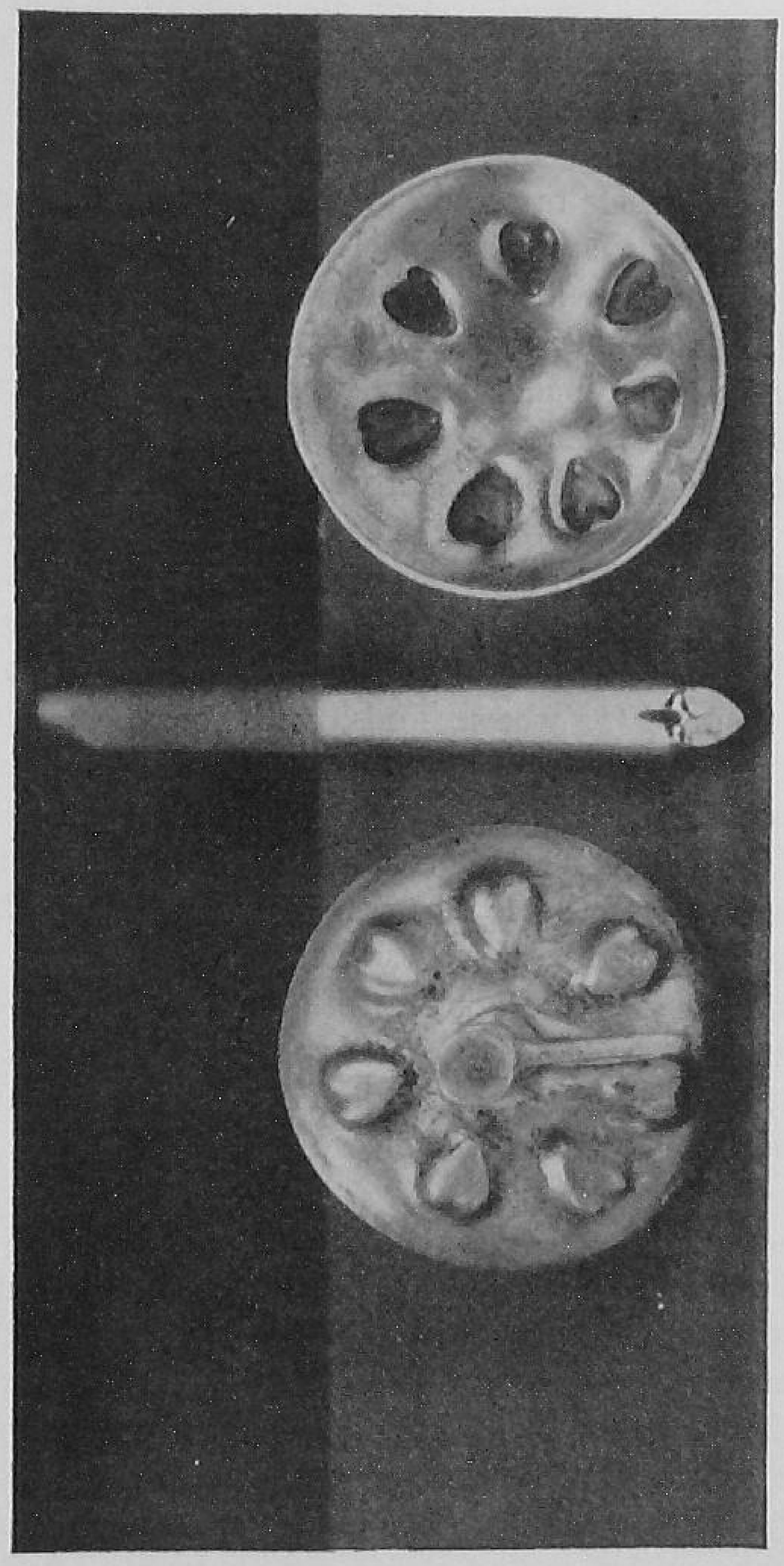


Fig. 42. Such ear-rings require only 15 minutes work. A punch was used for the embossed hearts.

the craftsman is using pieces of foil or other discarded tool steel, it is best to anneal the metal to make certain it is soft and can be properly hardened later. Tool steel is annealed by heating in a blue flame until it glows red. Do not overheat to orange—this damages some steels. The steel must then be set aside to cool in air or may be laid in sand to cool. The object is to allow the steel to cool slowly. When cool enough to handle, it may be ground or filed to required shape. A tracer is ground as shown in Fig. 31. Dimensions vary according to the size tool wanted. When the tracing edge has been made, it may be touched up with an oil stone to make sure its surface is smooth. The edge may then be polished on its working edge, to avoid an actual sharp edge. Told the edge against a hard felt wheel charged with tripoli. The edge should be held so that its broad surfaces are parallel to the sides of the wheel. Polish lightly, rocking to polish the full curved edge. The two slanting surfaces that form the edge should be polished, being held so that the surfaces are flat against the polishing surface of the wheel. Finish with rouge. Be careful not to use great pressure, and pay attention to the safety precautions mentioned in the chapter on polishing.

Raising tools, as well as specially shaped stamping tools, can be filed to shape and polished. Small needle files were used to make the heart-shaped "punch" used in making the earrings shown in Fig. 42.

Fine emery cloth used in conjunction with lubricating oil is excellent for finishing off tools that have been ground or filed to shape. If such tools are polished without the use of emery cloth and oil, the marks formed by the grinding wheel or file will be made very obvious.

Matting Tools.

A method of making matting tools is the following: Select an old file of the 6″ or 8″ flat variety. Lay it flat on a work bench. Heat to a red heat the end of an annealed piece of tool steel. Have a large can or pail of cold water close at hand. When the end of the steel is red hot, grasp the steel near the center with a sturdy pliers and place the red hot end of the tool steel against the teeth of the file. The end of the steel, of course, should have previously been filed perfectly flat. Strike the top of the steel piece sharply with the flat of a 1-pound ball-peen hammer. Now heat the end red again and plunge it into the water, stirring while it is kept immersed. Thus, the steel, which will have a reverse imprint of the file teeth, will now be hardened. Stirring in the water keeps the steel constantly in contact with cold water. The sudden change in temperature is necessary for

proper hardening. Test for hardness by lightly pushing a small, sharp file across the end of the tool. When properly hardened, the steel will resist the cutting action of the file, which will seem to slide over the tool smoothly without "biting" into metal. If, for any reason, the file "bites," anneal the tool and then harden again, by heating red hot and plunging it into cold water. This same hardening process is used for the other chasing tools, and it is always preceded by the annealing process. It is not necessary, however, to do it immediately after the annealing process—no time element is involved. At this point, it is well to note the different effect such a heating process has on carbon steel in contrast to the effects on silver, brass, or copper.

When a piece of steel is hardened in the manner described, it is in its hardest but most brittle state. To keep it hard and yet eliminate the brittle quality, the tool must be tempered. This is the third and final heating process used in making the chasing tools.

Tempering Steel Tools.

Before tempering, the otherwise *completed* tool is cleaned at its working end. This is easily done with very fine emery and oil, or a piece of worn emery and oil. The object is to restore the original silvery steel color on the front or working end of the tool. Tempering is done to remove the brittle quality of hardened steel or to remove inner strains and tensions. In addition, tempering imparts a particular degree of hardness to a piece of steel. To obtain the degree of hardness wanted, the steel must be heated to a specific temperature and then plunged again into cold water. Inasmuch as the small shop rarely has a pyrometer on hand to measure the heat of the furnace or flame used in tempering, another method of measuring can be employed. This method makes use of the oxides formed on the surface of the heated steel to ascertain the degree of heating and thus the hardness. The oxides appear in various colors, in a definite order. First to appear is a pale yellow, then a deep straw, then brown, purple, blue, and black. The ranges from yellow to blue are useful in tempering. The yellow indicates the extreme hard end of the scale; the blue indicates the relatively softer, springier, and tougher tempering. The color needed for chasing tools is deep straw. To obtain this color, the upper half of the tool shank is kept in a hot, blue flame. The flame will obscure the colors but the portion of the steel not actually in the flame—the lower half that is—will show the entire scale of colors. The deepest will appear close to the flame, merging with the rest of the colors in the scale, with the yellow

nearest the end of the tool. When this yellow color slowly creeps down to the tip of the tool, it is plunged into cold water. The upper half of the tool will not be very hard, but this is not necessary, and will eliminate the chance of the tool's snapping in two. If the entire tool were tempered an even yellow, the upper end of the tool would probably injure some hammers, and the shank of the tool would be likely to snap.

Another and somewhat better method of tempering requires a small gas burner or stove. A plate of iron or steel at least 1/8″ thick and large enough to accommodate a chasing tool is heated over the gas burner. The chasing tool is then placed on the hot plate, with the lower working end or point extending over the edge of the plate for a distance of about one inch. Keep the plate heated and watch for colors. Allow the major portion of the shank to go through the colors until purple is reached. Then push the tool point back so that the entire tool rests on the heated plate. Concentrate attention on the tool's *point* and when a deep straw color is reached plunge it into cold water. This results in a properly tempered point and an evenly tempered softer shank.

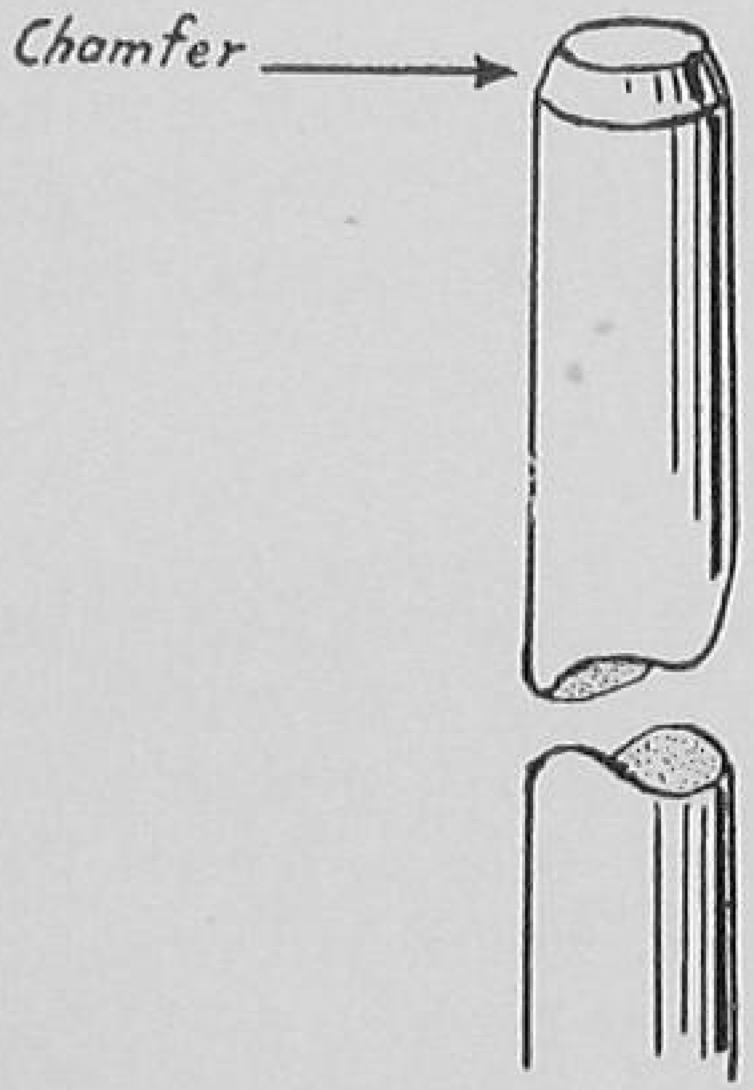


FIG. 43.

To finish the tool, it may be cleaned of all color with fine emery and oil or left as is. The only work really necessary involves grinding or filing a chamfer around the upper end of the tool (Fig. 43). This is done so that the constant hammering on this end does not form a "mushroom." Such a formation frequently results in cut fingers and should be avoided by the aforementioned grinding of a chamfer.

Chasing Pitch Formulas.

It is best to purchase prepared chasing pitch. It is not expensive, will last for a long period of time, and save the craftsman a great deal of the bother necessary in preparing such pitch. Yet should such pitch be difficult to obtain in a particular locale, a formula would prove of value, if the ingredients were obtainable. Also, it is to the interest of the worker to understand the nature of his materials as well as his tools.

An old and tried formula for chaser's pitch consists of Burgundy pitch and plaster of Paris in equal parts. The pitch is melted in a tin over a

moderate flame. When melted, the plaster is added slowly, stirred into the pitch until a homogeneous mixture is obtained. Five pounds of this mixture will suffice for ordinary use. About an ounce of tallow is melted and stirred into the mixture of pitch and plaster. During the winter, when pitch tends to become harder and less adhesive, the amount of tallow used in the pitch may be increased somewhat.

Another formula uses shoemaker's pitch, plaster of Paris, and rosin. These are combined by melting the pitch and rosin, and stirring in the slowly added plaster. The proportions for a 5-pound batch are 2 pounds pitch, 2½ pounds plaster of Paris, ½ pound rosin. Sometimes an ounce of tallow is added.

A common and reliable formula is the following:

2 lbs. green pitch
3 lbs. plaster of Paris
¼ pint lard oil

The ingredients are combined in a manner similar to previous formulas. Here the lard oil takes the place of tallow; for decreasing the hardness of a mixture, lard oil may be added to the melted mixture.

A perusal of the foregoing formulas will show that they are all somewhat similar. Different workmen prefer slightly different mixtures. Sometimes lard oil is used, sometimes tallow. The pitch is always somewhat similar regardless of name. Plaster of Paris has been successfully replaced by finely powdered brick, as well as by fine white sand. Plaster of Paris is generally the agent used *to increase* the hardness of a mixture, whereas tallow or lard oil *decreases* the hardness. Venetian turpentine may also be added to the melted pitch to make a softer mixture. Some craftsmen keep a separate winter and summer pitch mixture. The major precautions for mixing are the avoidance of lumps by thorough melting and stirring and the avoidance of igniting the mixture by careful heating over a moderate flame.

Chapter XI

USING MISCELLANEOUS SMALL TOOLS

The Draw Plate.

When it is desired to reduce the diameter of a length of wire or to change its cross-sectional shape a draw plate is used. The draw plate is also used, as will be explained a little later, to form small-diameter tubing. The plate consists of a series of holes, graded in size. These holes are tapered; on one face of the plate a hole appears larger than it does on the reverse side. Wire is fed through a hole on the large-diameter side and is drawn through, thus assuming the diameter of the hole at its smallest size.

Draw plates are made of hard, tempered steel and are available with hole-series covering different ranges. They are also available with holes having various shapes, such as half-round, oval, square, rectangular, etc. Plates are also made in combination types. These have a row of round hole and usually two other rows of holes of different shapes, such as square and half round.

The procedure in using a draw plate is the following: Remove any kinks in the wire. It is not necessary to straighten the wire very much, as the draw plate will have the effect of forming a coil anyway. File a long taper on the wire, about 1″ long, so that the wire will protrude through a hole just less than the wire diameter for the distance of at least ¼″. If the wire is not annealed, coil and anneal as described in the chapter on annealing. The wire should be frequently lubricated. Beeswax is an excellent lubricant, and the coiled wire may be dipped into a container of melted beeswax. Otherwise, one end of the wire may be held in a vise and, with the wire held stretched, a piece of beeswax rubbed its length.

The plate is then mounted in a vise so that wire may be drawn in a plane parallel to the floor. The plate's surface should be protected by placing "cheeks" of copper or other soft metal in the jaws of the vise. The wire is then fed into a hole not quite the diameter of the wire, and by gripping the tapered, protruding point with a draw-tongs, it is drawn through toward the worker in a straight line. The wire is drawn through a series of holes, skipping none, until its final diameter or shape is obtained.

It is usually necessary to anneal it after four or five drawings. Lubricate at each hole. Anneal the wire before it is put to use in jewelry work, unless its hard state is particularly wanted for some purpose. No silver is removed during the drawing process; the wire is merely lengthened as its diameter decreases.

Forming Tubing.

To make narrow tubing, annealed metal is cut from the sheet. Nos. 24 26, and 28 are commonly used gauges of metal, depending on the diameter of the tubing. The lighter weight is used on the narrowest tubing.

The width of the strip of metal to be used for tubing is determined by multiplying the diameter of the desired tubing by 3.1416 ($\pi \times D$). This is roughly three times the tubing diameter. The strip is then tapered on

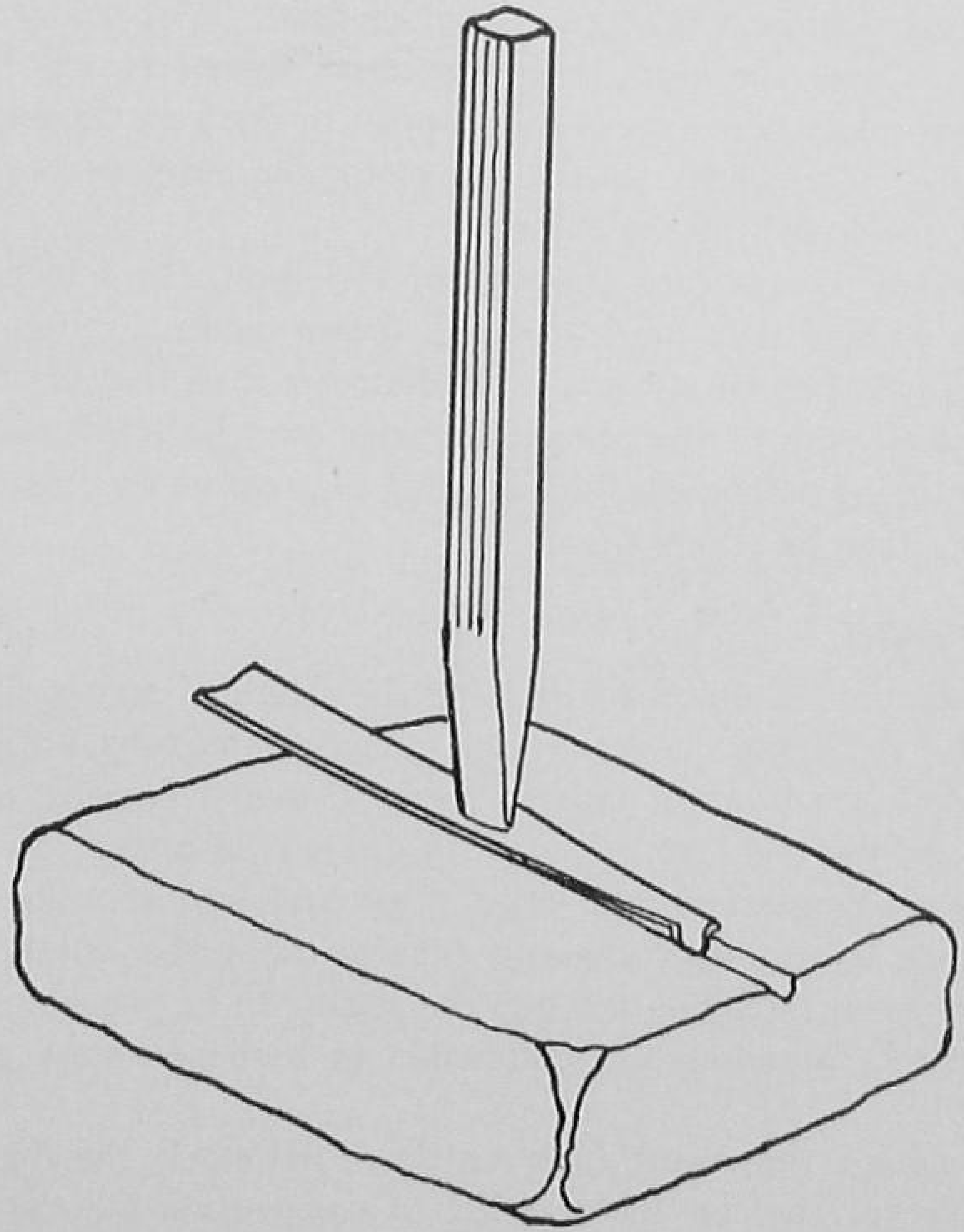


FIG. 44.

one end, by use of the shears, for a distance of one inch. Inasmuch as the tubing used in jewelry work is generally of small diameter, a narrow edged chasing tool may be used to start shaping the strip to a U-shape (See Fig. 44). The strip may rest on a block of hardwood or a lead block. In either, a narrow groove is previously made, over which the strip is placed, and shaped as shown in the figure. The tapered end is then carefully shaped to a point. A hammer, pliers, and file may be employed at different stages to accomplish this. Lubricate the strip with beeswax and draw through the nearest fitting hole.

Hold the far end of the strip with a pliers to prevent twisting. Continue through a series of holes until the edges meet and a seam is formed. Anneal and lubricate as necessary. Remove lubrication by a bath in hot caustic solution and hard-solder the seam. To do this, cover the seam with flux and place small pieces of hard solder about $\frac{1}{4}''$ apart. Heat to dry the flux and then heat tubing until solder flows. Wire solder may also be employed. Cover the seam with flux, heat tubing to red heat, and touch the hard solder wire (previously dipped in flux) to the seam of the bright-red tube. The solder should run along the seam as the flame is played along the length of the tubing.

If it is desired to eradicate any sign of the seam, the soldered tubing must *first be pickled* then lubricated and drawn again through the draw plate, using a hole just barely smaller in diameter than that of the tubing. A piece of piano wire of the proper diameter may be lubricated and inserted in the tubing before this final drawing to preserve the final diameter. The wire may then be removed.

The Ring Mandrel.

The ring mandrel is useful for forming the shank of a ring, for making wire rings, for reshaping distorted rings, and for stretching finished rings.

The mandrel is a piece of tapered steel. One end has the appearance of a handle and this end may be placed in the jaws of a vise. The mandrel may or may not be marked in a series of graduations indicating ring size. Some mandrels are cut with a groove running along the length to permit a ring with a stone extending through the setting to be placed and worked on the mandrel. Mandrels are obtainable in hardened state as well as non-hardened.

When forming a ring shank from a strip of flat stock, the shank should be frequently reversed on the mandrel to compensate for the taper. A rawhide or fiber mallet is used to beat the strip to form. If a shank having

the shape of a complete circle is to be formed, it may be roughly shaped, hard-soldered, and then trued on the mandrel. Wire rings are also shaped approximately, soldered, and then trued on the mandrel by use of a soft mallet. When a ring that has been partially crushed is to be repaired, it may be similarly worked on the mandrel. If necessary, the grooved mandrel is used, although, if too much work is not involved, it is preferable to remove the stone first. To stretch a finished ring, place on a graduated mandrel and carefully beat around its circumference with a flat polished hammer. This stretches the metal. Do not beat a decorated shank as the hammer will mar the decoration. A ring can be stretched only about one-half a size, unless it is made of unusually thick material. If it is necessary to make a ring considerably larger in size, saw through the back of the shank, beat to required size with a rawhide mallet, and insert a piece of metal where the sawed ends of the shank have separated. Hard-solder, reshape on mandrel, file and polish.

Mandrels are also available for bezel making in round, oval, square, hexagonal and octagonal shapes. For shaping bracelets, large mandrels of round and oval shapes are made, but pieces of iron pipe of various diameters may be trued on a lathe and serve as well or better.

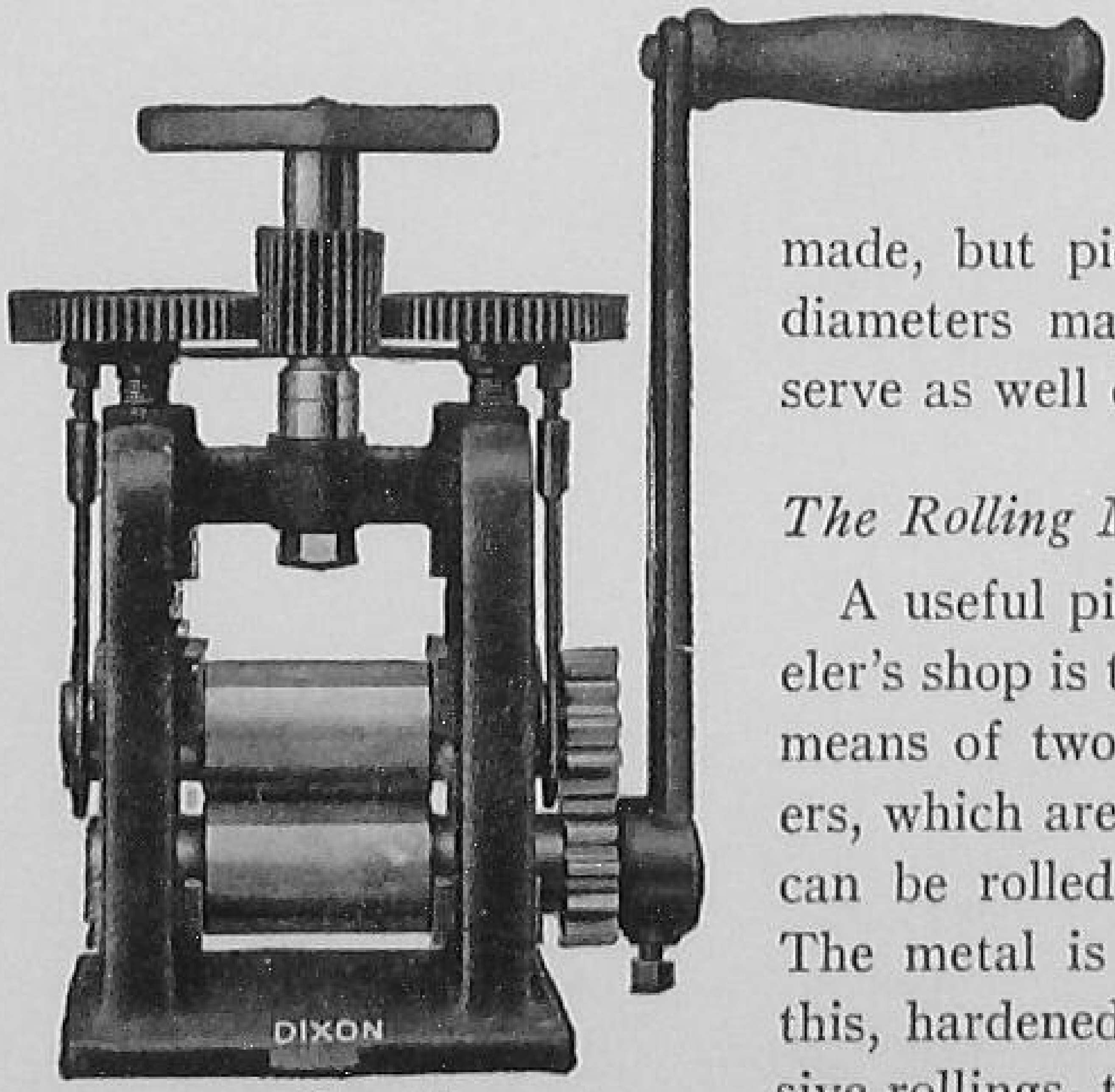


FIG. 45.

The Rolling Mill.

A useful piece of equipment in the jeweler's shop is the rolling mill (Fig. 45). By means of two hardened and polished rollers, which are parallel to each other, metal can be rolled flat to a desired thickness. The metal is compressed and, because of this, hardened. After two or three successive rollings, the metal should be annealed. The rollers should be so adjusted, by a geared wheel, as to make the reduction in thickness a gradual one. In feeding metal into a mill, the same end of the sheet should be fed through every time. Twisted and braided wire are sometimes fed to the rolling mill. The flattening effect is quite decorative. Special rollers are made to produce half round and square wire.

Pliers.

Among the most useful tools in the jeweler's shop are the pliers, which are available in a great variety of styles. Pliers should be of good quality tool steel. On hand should be round-nose and flat-nose pliers, of at least two sizes. Pliers are used for bending and forming operations mainly. A pair or two of gripping pliers should be kept available, but others would be improved by the careful removal of the serrations, or teeth, on the inside of the jaw. This may be done by filing or grinding, and should be followed by the use of emery and oil. A half-round-nose pliers has one flat jaw and one round or convex jaw. This is among the most useful pliers for bending curves. An excellent one may be made using a Pexto No. 200 flat-nose pliers as the basis. Anneal the "head" of the pliers. Remove the serrations from one jaw and hone it smooth and square with a fine oil stone. Round off the inside of the other jaw so as to get the effect shown in Fig. 46. Hone smooth, harden, and temper, as described in the chapter on chasing tools. Another pair of this same pliers may be reshaped so as to have both

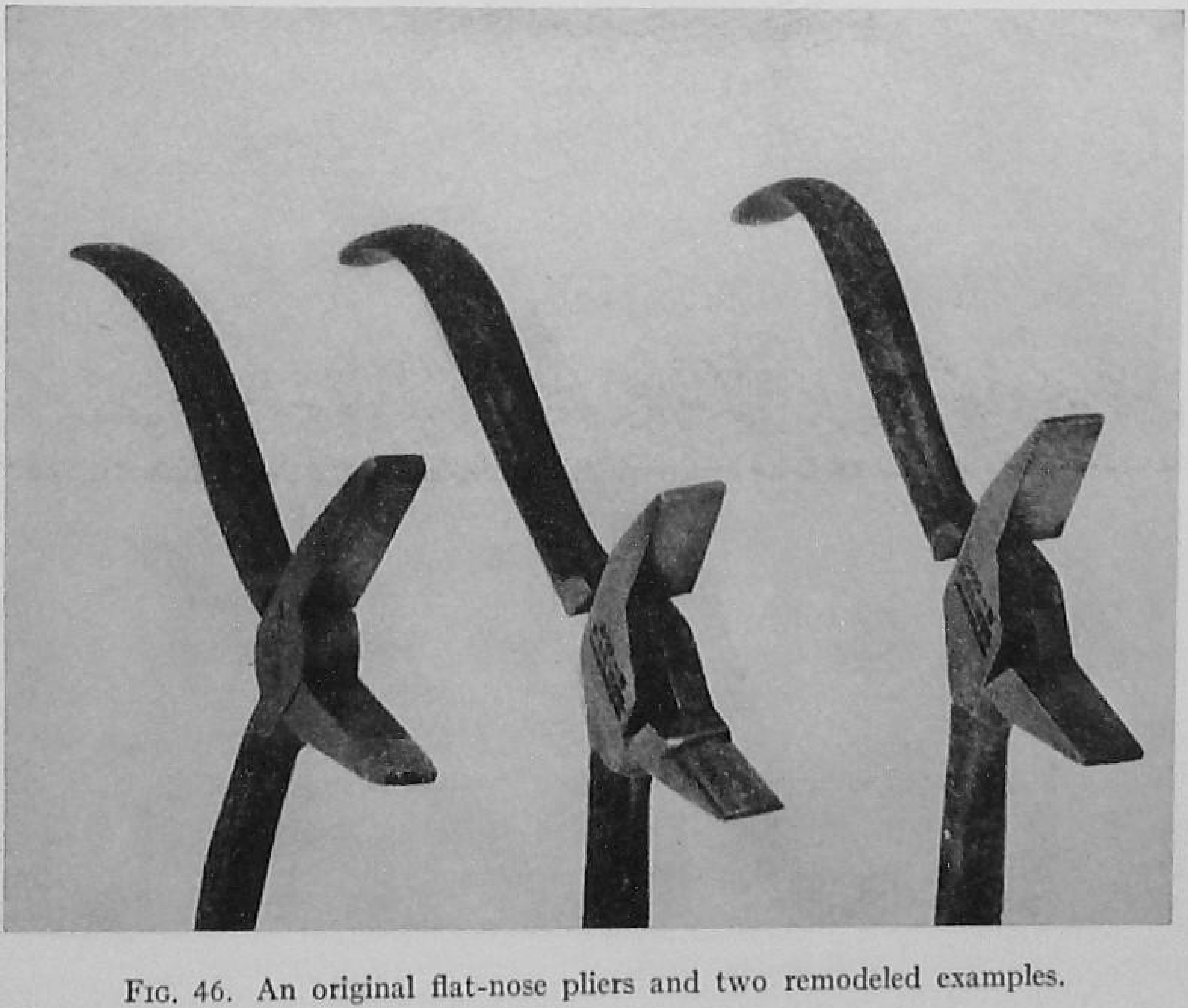


FIG. 46. An original flat-nose pliers and two remodeled examples.

jaws perfectly flat and smooth on the inside. Such a pliers may be used to good effect to obtain sharp, square corners when bending bezels, for example.

The Utica needle-nose assembly pliers No. 82 is unusual in having a long pair of handles and small but powerful jaws. When a very powerful grip is needed and little gripping area is available, this pliers will be found invaluable. A similar excellent pliers is the Utica duck-bill wiring pliers, in No. 31. A series of unusual pliers having a patent feature are the Bernard parallel jaw pliers. Of particular value is the flat-nose type. The jaws of these pliers remain parallel to each other regardless of the extent to which they are opened.

A pair of long, flat-nose pliers of a cheaper make should be set aside for handling hot work or for soldering. Such pliers should be used instead of spoiling more expensive, tempered pliers.

When it is desirable to grip or bend a portion of a job without leaving any marks, a strip of sheet tin-foil or lead-foil may be wound three or four times around each jaw of a pair of pliers. This procedure will safeguard work against possible injury.

A pair of side-cutting or end-cutting nippers should be used to clip the various types of wires used by the jeweler. Never use a shears or scissors of any sort to clip wire. The blade edge will be impaired.

The Drill.

A sensitive drill of the electric type is really a miniature drill press. These drills are useful for drilling operations and, in conjunction with burrs, for working on stone settings or cutting recessed areas. When purchasing twist drills for use in jewelry work, high-speed steel drills should be obtained in preference to carbon steel drills. The drills used are small in size and much breakage will be avoided by the use of high-speed steel drills.

When a drill is to be used, whether of the hand or electric type, a small indentation must be made exactly at the point at which the hole is desired. This is made by resting the work on a flat steel surface, and placing the point of a center punch on the mark. Strike the top of the punch a light blow with a small ball-peen hammer. The indented mark should be visible on only one side; do not try to drive the point through the metal. This tiny dent will prevent the drill point from "walking" over the surface of the metal and giving an inaccurate result.

When using the electric drill, place the work on the drill table, set the

drill in motion, and bring the drill down close to the surface of the metal. Then adjust the position of the work so that the center punch mark is directly under the point. Use a moderate pressure on the drill to avoid vibration or bending the drill shank. The worker should keep his eyes well above the level of the top of the drill table so that any metal thrown out radially from the drill table will not strike the eyes or face of the operator.

Pin Vises and Broaches.

The pin vise is essentially a tiny split chuck on a hollow length of metal comprising the handle. Thus, it is possible to insert a length of wire into the chuck, as the wire extends through the hollow handle. The end of the wire protruding from the chuck may be sharpened with a file for use as a pin. The end of the wire may also be "turned over" as a rivet head, while it is held in the pin vise and tapped with a small ball-peen hammer or the ball end of a small chasing hammer.

When a small hole is to be cleaned out or reamed slightly larger, as is sometimes necessary in the case of joint and catch combinations, a small twist drill or a broach is mounted in the pin vise. The handle of the pin vise may then be twirled backwards and forwards between thumb and forefinger, making of this tool set-up a miniature drill.

The Silversmith's Raising and Planishing Hammers.

A large variety of silversmith's hammers are available and some of these can be of great value to the jewelry worker. The heads of these hammers are usually cast of a good grade of steel. Some are hand forged. All have polished striking surfaces. These surfaces vary in their areas, shapes, and curvatures. Such hammers should be kept in perfect condition and should never be used for striking other tools, such as center punches or chasing tools. The hammers are designed to do their work on metals softer than steel.

The raising hammers are essentially for raising bowls and large hollow-ware of metals such as silver and copper. They are valuable to the jeweler as a means of giving shallow smooth curves to objects of jewelry. For example, if a design is chosen consisting of the stylized outlines of an animal, the cut-out silhouette is given added depth by slight raising. To do this, the worker must first contemplate the area he wishes to "raise." He then selects a polished raising hammer with a curvature related to that area. By doing this, his hammer blows will not leave a series of small raised

"bumps" on his work. Rather, the work will gradually become concave on its reverse side, while the surface of the metal remains virtually unmarred. When this raising is done, the work rests on a lead block. It sometimes helps to pound a slight gradual depression into the lead block with the raising hammer. The work may then be placed over this depression and pounded, from the reverse side, to the desired outcome. (Fig. 47*A*.) The curvature of such hammers is more important than the area, although when both curvature and area are somewhat similar to the shape desired with regard to the work, the process of shaping is much easier. The work may be set in a pitch pan as described in the chapter on chasing and the section on doming, instead of utilizing a lead block.

Planishing has become a treatment of a metal surface to give it a "texture." Originally, objects "raised" from metal retained the slight irregularities of surface caused when the object was beaten to shape with steel hammers. These marks disappeared when objects in modern times were stamped or spun to shape, without the use of hammers. However, the modern technique was evolved for mass production and hence created a cheaper product. Manufacturers then evolved the idea of creating "false" hammer marks to liken the product to the old hand-made work. Hand-made products were more expensive and thus were aped by the modern makers. Actually, the texture resulting from the skillful blows of the early artisan with his well-polished hammers was quite decorative in itself. To-day, silverware and jewelry frequently sport the "hammered" finish.

This surface treatment should be employed with good taste, not haphazardly. It should not be used to decorate a surface that would seem to be smooth by nature. The area of each hammer mark—which depends on the curve of a hammer surface—should bear a relationship to the area of the work in its entirety. The hammering itself is not done until the planishing hammer selected is inspected and found to possess an unblemished striking surface. Laziness and carelessnes are behind the use of damaged hammers, as well as poor taste. Blemishes of a minor character may be removed by the judicious use of fine files, fine emery cloth, crocus cloth, and the polishing wheel.

When a perfect hammer is selected, the metal surface to be planished should be brought to a state of equal perfection. Dirt should be removed with fine steel wool, and the blemishes thus revealed removed by careful work with emery cloth. When every scratch has been removed, the metal may be polished at the wheel, providing a final polished result is wanted. If polishing is done after hammering, the crispness of the hammer marks is

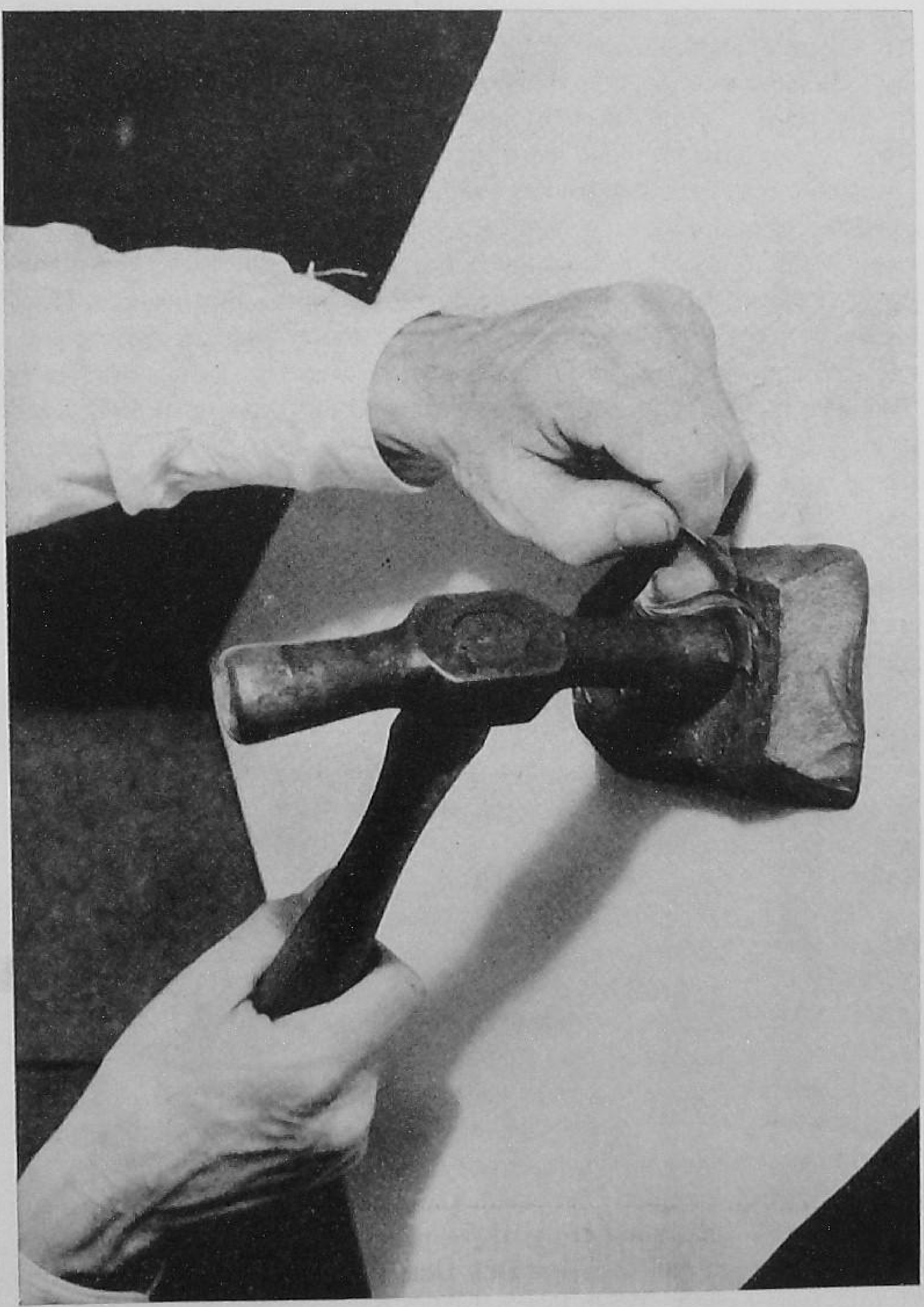


FIG. 47A. Using a raising hammer and a lead-block for shaping the leaf shown in Fig. 34.

deadened decidedly. Assuming the metal to be ready, place it, if flat, on a flat steel plate at least ¼″ thick. The hammer mark will depend on the weight of the blow, so determine by practice, if a novice, the blow necessary. Then, using the *wrist* for the blow, instead of the arm, strike the hammer blows on the metal surface. Avoid hitting the steel plate. Each blow should produce a bright concave "mirror." The handle of the hammer should be *parallel* to the bench top when the hammer face contacts the work. Remember when hammering a surface that two results are concomitants of this process: (1) The metal is hardened, and (2) a delicate outline may be somewhat distorted at the edges. If desired, the work may be annealed (not generally desirable) and the edges filed smooth and polished (generally desirable).

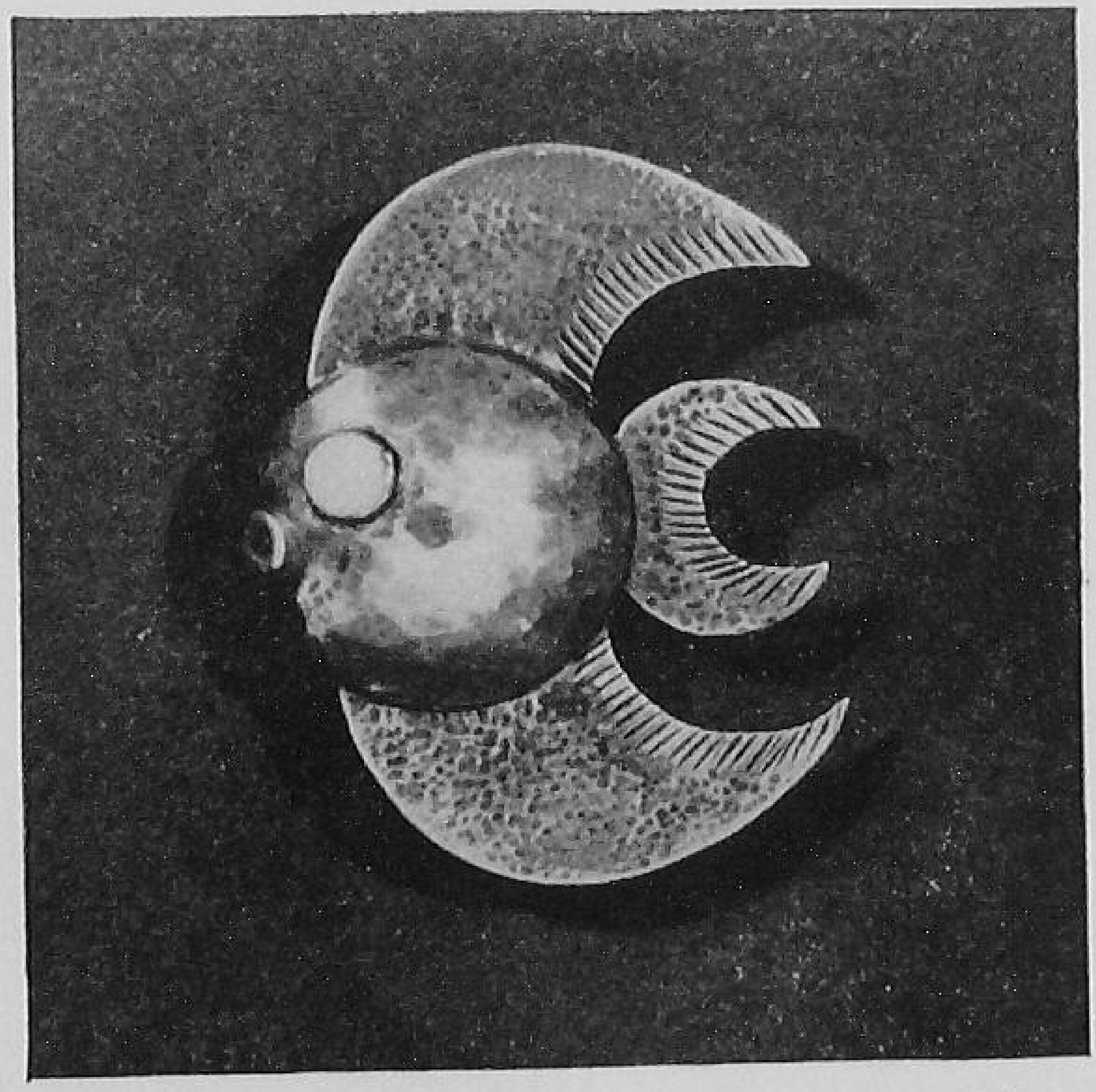


FIG. 47B. A pin showing reasonable use of "peening" on a surface.

If a piece of metal is to be domed as well as planished (Fig. 47*B*), it is well to dome first and planish later. This is because of the stretching involved in doming. When a hammered surface is stretched, the hammer marks lose much of their character. Therefore, domed pieces of metal to

be planished are placed over "stakes" and hammered on the outside, or convex, side. A smooth, polished stake should be used, and care must be taken to see that the work is in contact with the stake when a hammer blow is struck. Otherwise the domed piece will collapse slightly at each blow. A study of the tool catalogs issued by the large jeweler's supply houses will afford a clear understanding of the types of hammers available.

Chapter XII

CASTING JEWELRY

The craftsman who is engaged in the small-scale production of hand jewelry has two methods of casting available for his use. One method involves the use of cuttlefish bone as a medium for creating a mold. A second method utilizes fine casting sand and a flask, consisting mainly of a cope and a drag.

The cuttlebone method, which is fully explained in the following pages, is a simple, effective method of casting a basic ring. The ring may then be carefully finished and engraved, or it may serve as a basis for a more complex piece of jewelry involving a setting for a stone and applied ornamental pieces.

Cuttlefish Bone Casting.

Cuttlefish bones are available in three sizes. The intermediate or medium is most frequently used for making small jewelry, such as finger rings. Note that of the two broad surfaces of the bone, one is soft and spongy, the other hard and brittle. Both surfaces are somewhat domed. Because the ring pattern is to be sunk to half its depth in each of the flat surfaces of two bones, compare the thickness of the two bones to the widest portion of the rings, remembering that the soft, domed surface will be sanded flat before use.

When two suitable bones have been selected, they are trimmed with a hack-saw (Fig. 49, whole series) by cutting from the soft side until the bone-like shell is reached and then breaking off the unnecessary edges. The two rectangular pieces produced should be fairly equal in size. The soft surfaces of each are to be rubbed flat and true. This is done by using a piece of plate glass about 10″ x 12″ or a surface plate of similar size, covered with a piece of No. 6/0 sandpaper placed abrasive side up. The soft side of the bone is rubbed with an oval motion on the sandpaper, making certain that the hand moves in an accurate plane, *parallel* to the

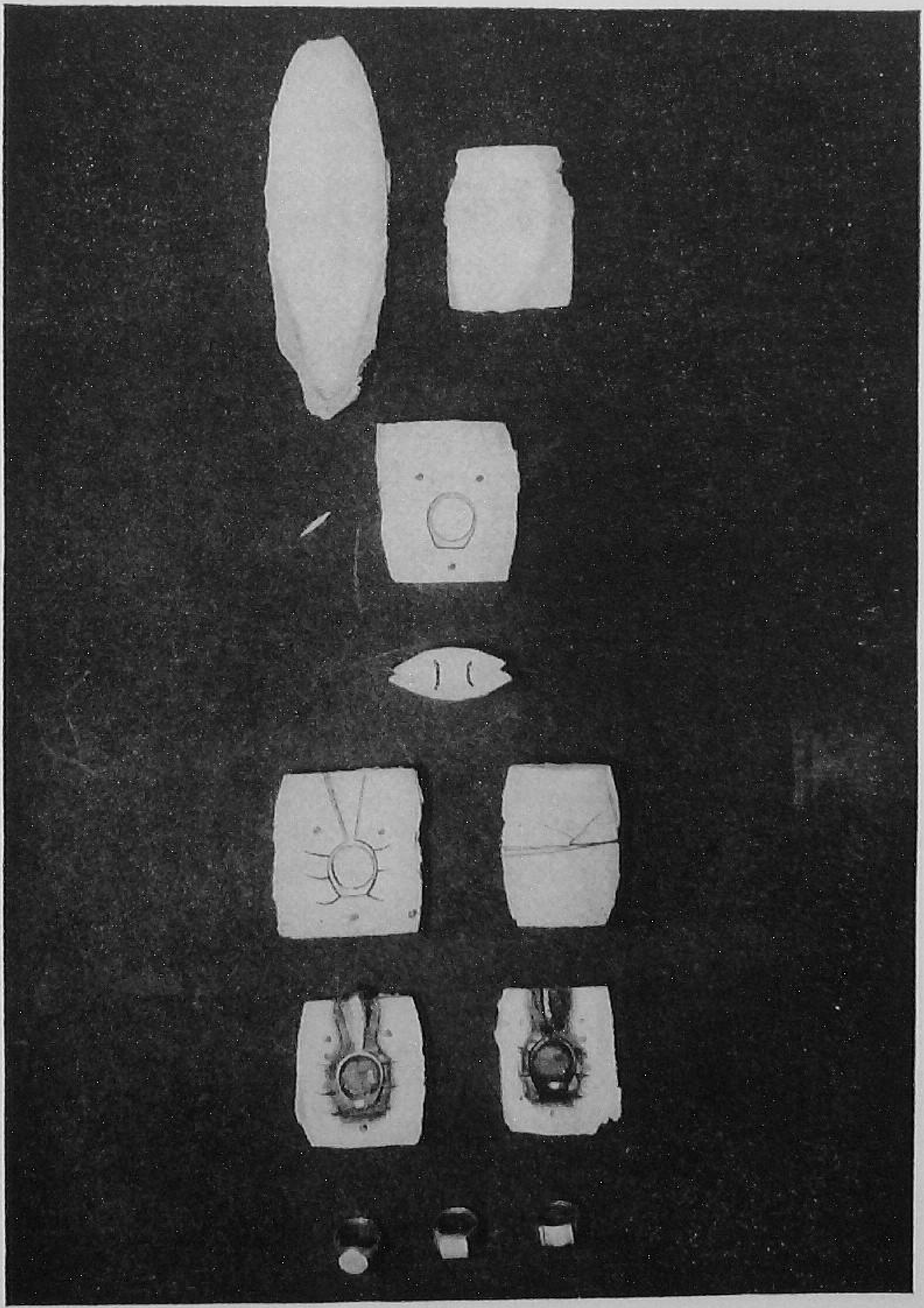


Fig. 48. Various stages in casting in cuttle-bone, and some semi-finished resulting rings.

plate's surface. It is best to rub until an area is made flat which will allow a flat margin around the ring pattern about ½″ wide.

The two flat, soft surfaces may then be sprinkled with extremely fine, pure, graphite powder, which is gently rubbed into the surface. The ring pattern is then pressed very carefully into one of the bones, until it has reached a depth equal to half its width. Note the position of the ring model in the bone (Fig. 48) which permits the cutting of a fairly long funnel or "gate" into which the molten metal is poured.

Now prepare three pegs, about ⅝″ long, and pointed on each end. These pegs are made of common wooden matches and are pressed for half their length into the cuttlebone containing the half-sunken ring. Note the position for each peg in the photograph. Observe the space left clear for the "gate."

Now press the second cuttlebone over the first one, keeping the edges of each in good alignment. Hold the cuttlebones in the palms of the hands, keeping the pressure equally distributed over the outer surfaces of the cuttlebones, and apply pressure. Clasping the hands containing these bones and placing them between the knees (Fig. 49) will aid in applying sufficient pressure. One half of the ring and each peg will now be pressed into the second bone.

The gate must be cut next. Notice that it meets the back of the ring. This is always done so that the decorative front portion of the cast ring is unharmed by the metal remaining in the gate. Mark off the width of the top of the gate on the proper end of the mold. This width should be about ⅝″. Use a sharp scriber for marking. Now carefully separate the two halves of the mold. The pegs make it possible to align these halves properly when necessary. Remove the ring. Take care to leave a clean, sharp impression.

With a narrow-bladed sharp knife, "pare out" a gate extending from the top end of the mold to the ring. The width of the gate at the ring should be about $\frac{3}{16}$″. The gate is cut in *each* half, so that the two halves together form a mold with a funnel cut into one end.

Sprinkle a little graphite into the two halves of the *impression*. A small cardboard container of graphite, with a nozzle, may be used for this. Such an item is frequently available in automobile supply stores, as well as in hardware stores. A similar but empty container may be kept and used to blow clear the impressions made in cuttlefish bone. Replace the ring and press the two halves together again. Now, when the ring is again removed, a clean, heat-resisting impression will be seen.

In order to prevent the trapping of air and gases in the mold, the impression must be vented. To do this scratch a series of fine lines extending upward from the impression to the outer edge of the bones. Make sure these lines are clear at the impression (see Fig. 48). These lines, which are cut with a scriber, are particularly important near the bottom of the

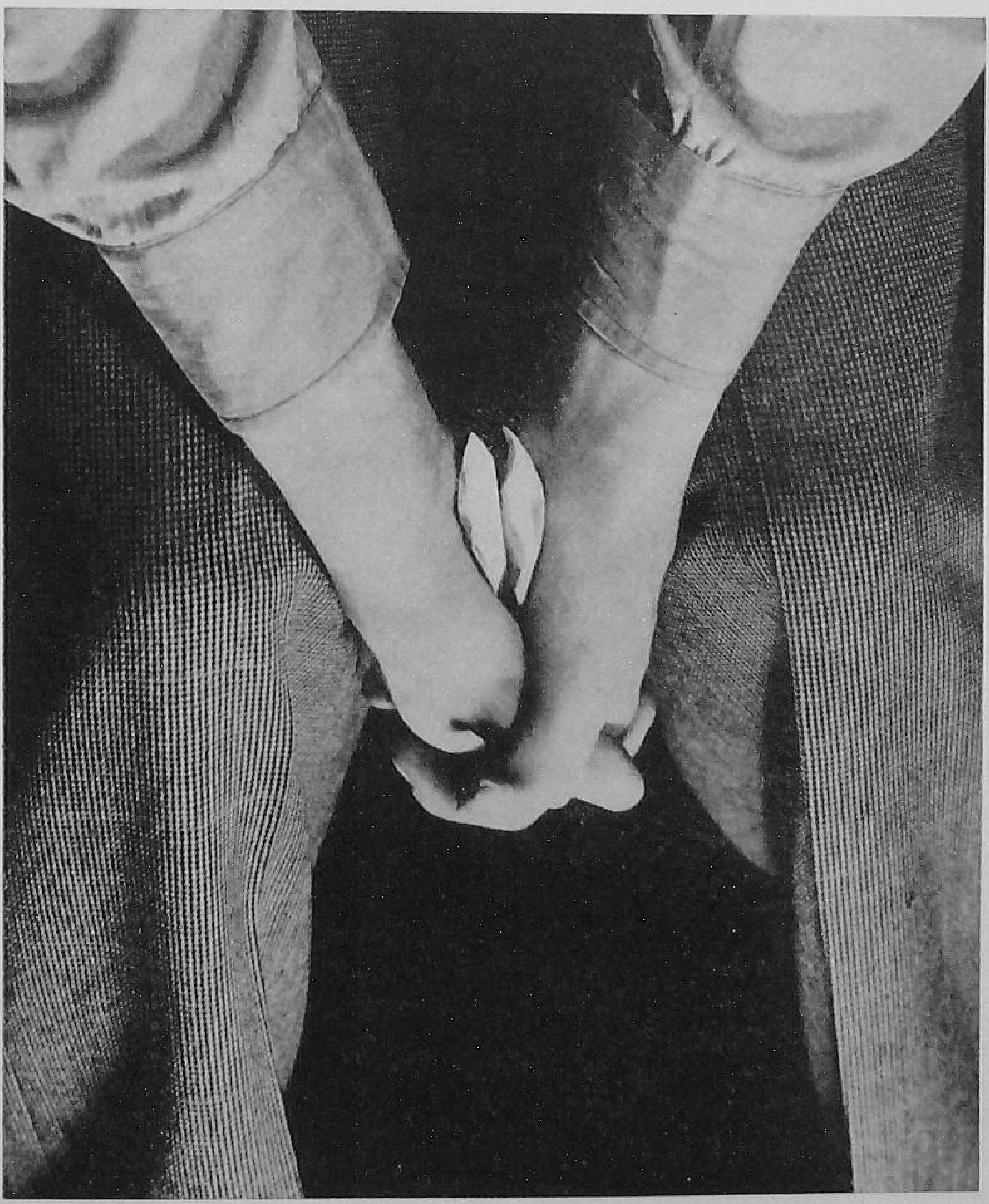


FIG. 49. Method of obtaining final pressure for a cuttle-bone impression.

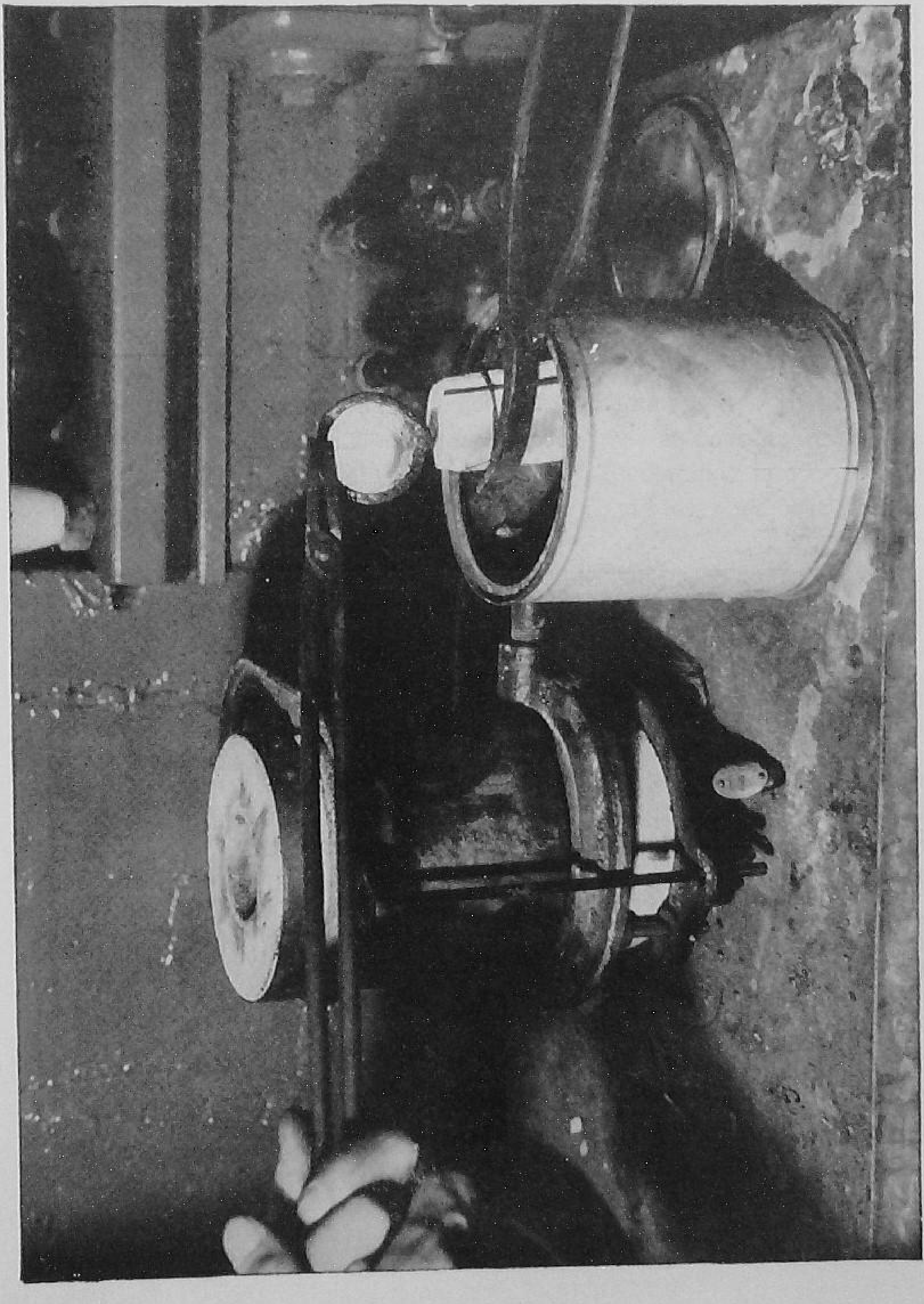


Fig. 50. Pouring the molten metal into a cuttle-bone mold.

impression. They should not be so large as to permit the molten metal to run through them.

Blow clear, and assemble the mold with pegs in place but with the ring pattern removed. Tie the two halves firmly with fine binding wire. The two flat surfaces should fit snugly without any sign of rocking. The mold may be held in a specially bent long tongs, or it may be set upright in a pan of clean, *dry* sand. If a tongs is used, hold the mold over a pan of sand in case any molten metal escapes (see Fig. 50).

Melting the Metal.

The metal to be melted may be brought to its molten state in a crucible, either held by a tongs and heated with a large torch, or placed inside a gas-air furnace, such as the "Little Giant No. 1." This furnace uses gas and a supply of compressed air. If the crucible-torch method is used, a blowpipe crucible (see Fig. 51) should be secured. The metal scrap or

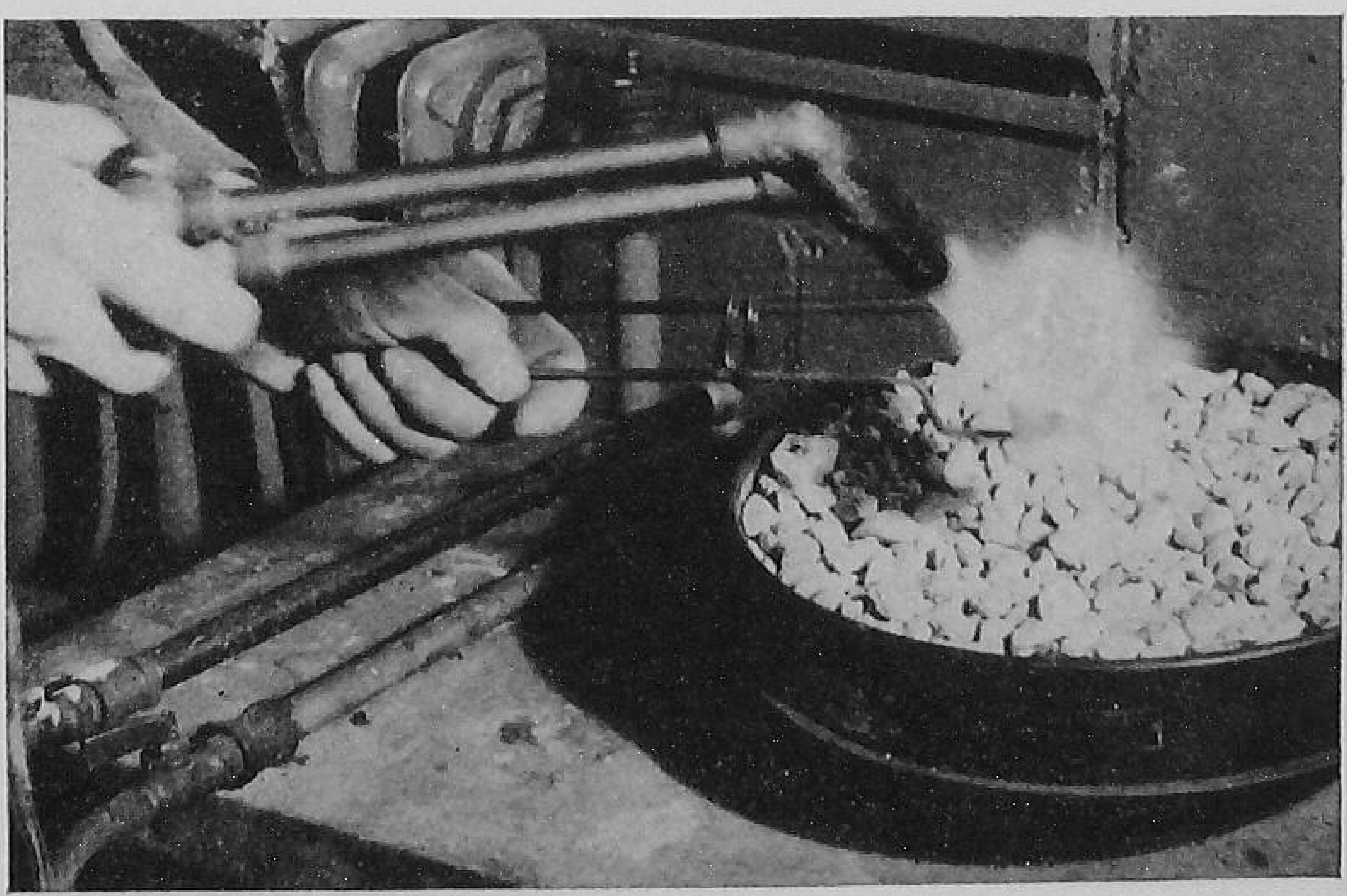


Fig. 51. Heating the metal in a blow-pipe crucible, using a gas-air torch.

cuttings should be placed in the crucible and prepared reducing flux sprinkled over it. The crucible is held in a crucible tongs. The flame from a large gas and air torch is played into the crucible until the metal melts down and begins to "spin." Add a little more reducing flux, keep the

flame on the metal, and then agitate the metal slightly by a gentle rotary motion of the arm. This causes any slag that may form to move aside, permitting free pouring of the metal. If any slag pours along with the metal, it will result in an imperfect casting. The metal is poured when in a "spinning" state. The flame is kept on the metal in the crucible during pouring, to keep it fluid. Pour until the gate fills to the top. When the "button" (as the metal remaining in the gate is called) loses its redness, clip the wires holding the two halves together. Knock the mold apart with a tongs and carefully place the finished casting into an acid pickle. The casting should next be rinsed clean and the "button" removed. This is done by clamping the "button" in a vise and sawing off the ring, leaving a slight amount of excess metal on the shank to be filed off in the finishing operations. The cuttlebone mold, of course, is used only once.

The appearance of tiny holes or pits in a casting is due to the absorption of gases. This may be avoided by using a reducing flux, avoidance of overheating, and rapid melting of the metal being cast.

The ring is filed to its final shape, at which point it may be polished and engraved, or embellished with stones or added ornament and then polished. It is not necessary to lacquer a silver ring unless it is to be placed on display for an extended period of time.

Further Notes on Cuttlefish Bone Casting

Using a Single Bone.

It is frequently possible when using the larger size cuttlebones or in the case of a small casting to use a single cuttlebone, cut in half, for a complete mold. When this is done, there is very little change in procedure. The bone is cut across its length. It is generally left untrimmed, and the gate is cut from the flat edge left by the sawing. The pegs are inserted as described previously. Other operations are the same. It should be made certain at the start that it is possible to fit the model ring into the bone, inasmuch as the heaviest portion of the ring will come out at the narrow tail-ends of the bone.

Ring Models.

In selecting models or patterns for casting in cuttlebone, many common commercial rings may be used providing there is no "overhang" or any undercut portion. The model selected should be so shaped so that it is possible to press it halfway into a cuttlebone with smooth results. Upon removal, it should leave a true imprint of its actual shape.

A slight alteration in the width of a ring is possible. To make a model narrower than the original, press it somewhat less than halfway into each half of the mold. To make a model wider than the original, first press up a mold in the orthodox manner. Open the mold again. Now insert the model in one half of the mold and press it deeper than half its width. Remove it from the bone and do the same to the other half of the cuttlebone mold. When the mold is reassembled, with the pattern removed, it will accommodate a ring wider than the original.

To alter the *size* of a finished casting, saw a small section out of the back to make the ring smaller. To enlarge the ring size, saw through the back, carefully spread open, and add a piece of metal. Hard-solder the seams in either case and file smooth to shape. Only small alterations are possible.

Using Silicate and Borax Solution.

Some jewelers substitute for graphite a silicate and borax solution which gives finer detail on castings where this fine detail is necessary. This solution is used as follows: Mix borax and water in a fairly strong solution but keeping it fluid. Mix separately a solution containing equal parts of silicate of soda and water. Make the impression in the bone and gently blow it clear of any tiny bone particles. With a good camel's hair brush coat the impression carefully with the borax solution. The silicate of soda solution is now coated over the *wet* borax solution. Allow the water to seep into the bone for a short while and then, with the mixture *still damp*, return the model or pattern to the mold and press the two parts tightly together again. When the pattern is removed, the impression should appear very smooth and sharp. The mold may *not* be used until every vestige of moisture has dried out of the bone. Keep the mold open and bake it slowly until certain no moisture remains. Do not apply a flame to the face of the mold. When certain that all moisture has evaporated, the mold may be retied with binding wire and the pouring operation may go ahead as previously described. Remember *never* to pour molten metal into a moist or damp mold. The resulting steam will violently drive the molten metal up out of the mold, scattering it around with possible injury to the worker.

A Second Silicate-Borax Method.

Another method of utilizing silicate of soda and borax for securing finer detail in cuttlebone castings is the following: Equal parts of silicate of soda and borax are mixed with enough water to make the mixture fluid.

This mixture is applied to the impression as previously mentioned, but in a single operation. When the mixture beings to dry, dust the impression with a fine parting powder, such as used in sand casting, and reset the pattern in the mold. Press the two cuttlebones firmly together again, separate, and remove the pattern. A sharp impression should result. Bake dry, retie, and pour as previously described. Before retying, care should be taken to clear the air vents previously cut in the faces of the mold halves with the scriber.

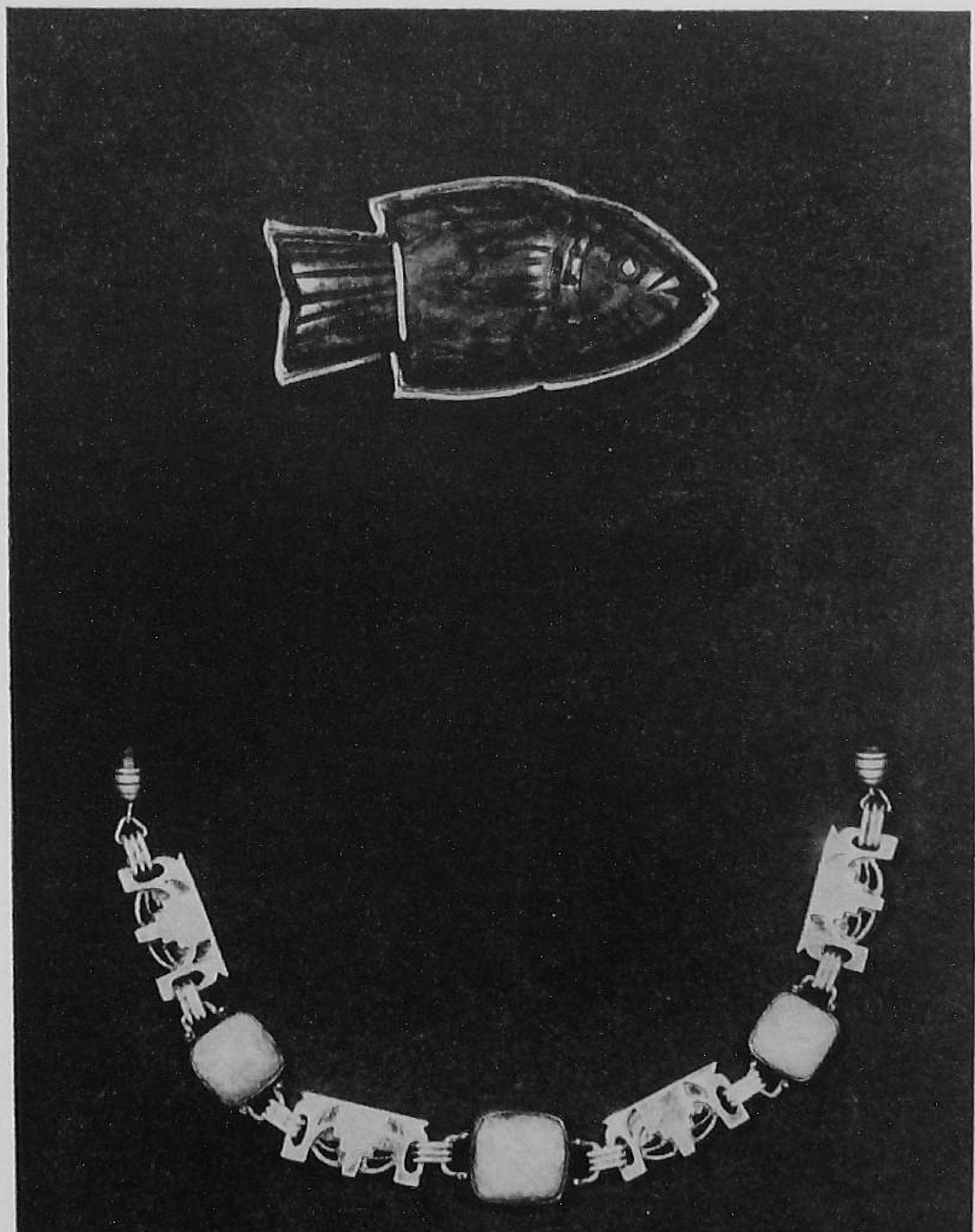


FIG. 52. (a) A native-cut Mexican stone set with a rivet and tie-wire by the author; (b) linked bracelet containing square cabochon stones set in bezels.

Chapter XIII

STONE SETTING

Precious and semi-precious stones in the creation of hand jewelry add greatly to the color, interest, and beauty of one's work. Large, important-appearing stones are usually the basis of the design of a piece of jewelry (Fig. 52). Small stones frequently point up a design based primarily on

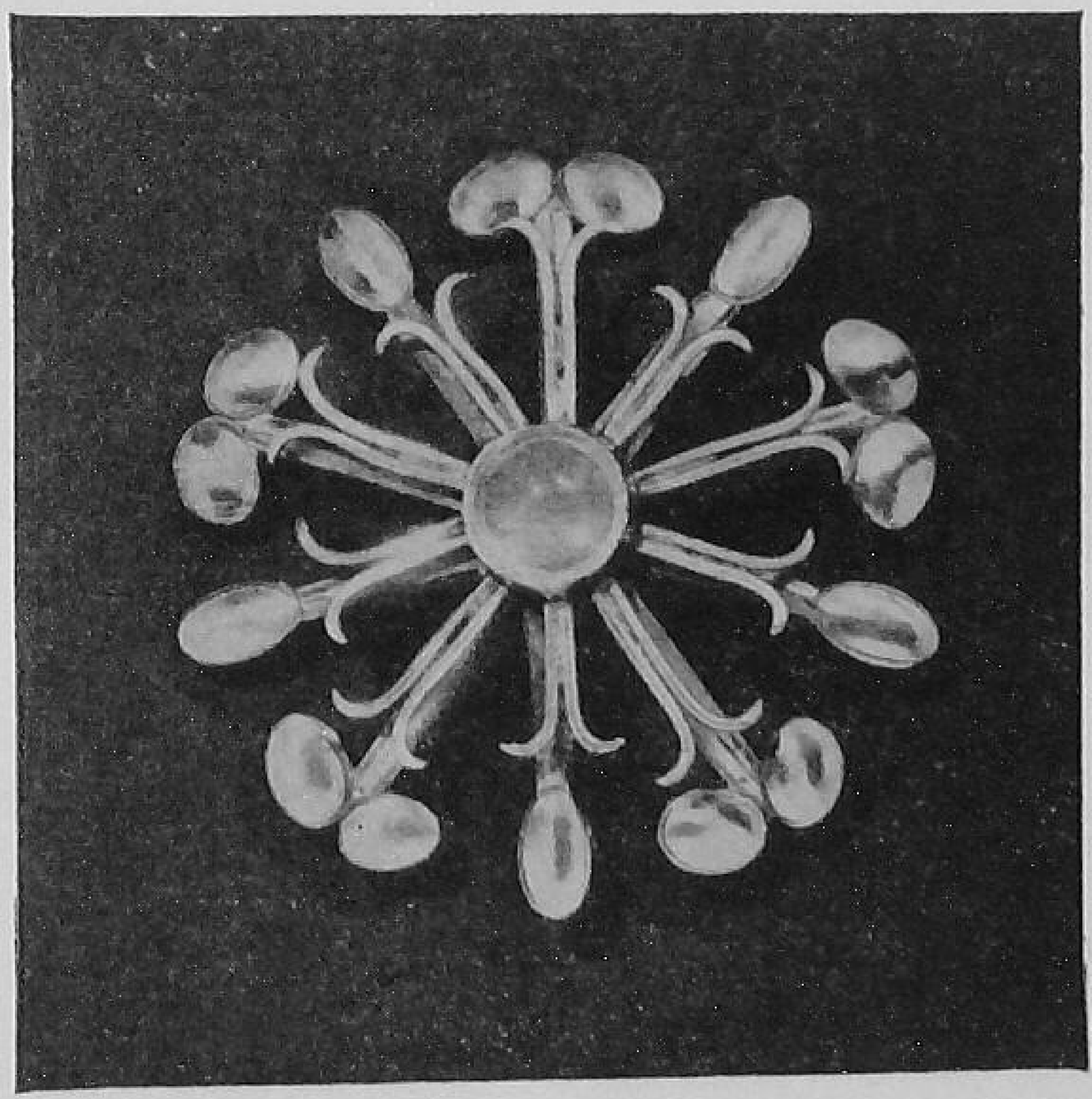


FIG. 53. Mounted moonstones. (*Courtesy of Anna Halasi.*)

the manipulation of the metal (Fig. 53). The various elements of a design should not vie with one another for interest; hence, stones are used only after considerable thought has gone into the design as a whole.

The most popular type of stone used for hand jewelry is the cabochon-cut type. Such a stone is cut to present a domed surface with a flat base.

It is a popular type of cut for colorful semi-precious stones, and is available in stones cut with square, round and oval bases (Fig. 52).

Flat, polished stones are also used, as well as the well-known, antique "scarab" style. Faceted stones are those cut with a multitude of geometri-

FIG. 53A. Coins as basis of simple brooch.

cally arranged surfaces, accurately cut and polished on different planes. This type of cut is reserved for transparent stones, and is responsible for the brilliance and "fire" in many otherwise less sensational stones. The faceted stone is not so frequently used in hand jewelry. One reason is that it looks its best in a delicate, pronged setting not generally used by many workers in hand jewelry. Another reason is that a faceted stone often requires only a setting; the stone itself comprises the actual jewelry. A group of various cut stones appears in Fig. 67.

The Bezel.

The bezel may be thought of as a low fence or rim around a stone with the upper edge turned in to prevent the loss of the stone. Bezels are made round, oval, square or rectangular. A bezel setting is most popular for cabochon-cut stones, although it is used occasionally for multi-faceted stones set very low in a ring. The bezel may be merely a low rim soldered to a flat surface to receive a stone. Frequently, however, the bezel contains an "inner bezel," or bearing surface, usually made of square or round wire, shaped, sized, and soldered so as to fit just inside the outer "holding" bezel. The purpose of this inner bearing is to provide a level, even base for the

stone when the bezel itself has been altered to fit over a curved surface At other times, a bezel is made high, either to raise the stone on a piece of jewelry or to allow for decorative treatment around the base of the bezel. A high bezel, however, requires the use of an inner bearing in order to prevent the stone from dropping deep into the setting.

The bezel is best made of the fine silver, although sterling may be used. The advantage of the fine silver is its softness, making it easy to turn the bezel edge over the stone with a burnisher. Once burnished, the fine-silver bezel is sufficiently hard to withstand use. The fine silver is also less likely to melt when being soldered, a point important to the novice at hard soldering. Fine-silver sheet of No. 26 gauge may be used for the bezel. This may be cut with a small, sharp shears to the width required for the stone.

FIG. 54.

The bearing may be No. 20 or No. 18 square or round sterling wire. Sometimes the bearing is cut from sheet sterling. No. 22 gauge may be used and, naturally, the width of the strip should be less than that of the bezel material. To determine the width of the bezel, consider a cabochon stone used in two ways. Fig. 54*A* shows a stone set flat upon a surface with a low rim. No bearing is used. Fig. 54*B* shows the stone set high, resting on an inner bearing. The bezel, of course, is much wider in this case. In either case, enough width is given the bezel to permit the upper edge to be turned in over the curve of the stone, holding it firmly in place. The curve of the domed surface must be considered carefully, and *only enough* bezel allowed to hold the stone. *Too much* metal will not turn in without puckering, and will also tend to obscure the stone.

To measure the diameter of a stone, turn a piece of No. 24 or 26 binding wire around the stone at its girdle or widest diameter. Twist the ends tightly and remove the loop. Cut this loop and spread out as shown in Fig. 55. This will give the length of the bezel. A rectangular stone may be measured for its bezel by ruling a line on a piece of paper. On this line, lay off, with a pair of dividers, the length of each side of the stone. If

these lengths are laid off end to end, the total length will equal the length needed for a rectangular bezel.

To solder a round or oval bezel, follow the soldering directions given in the section on bezel soldering, Chapter II. All that is necessary is to have the ends meet. The bezel may be shaped on a round mandrel after soldering has been done. Avoid using a greater length than necessary. The bezel

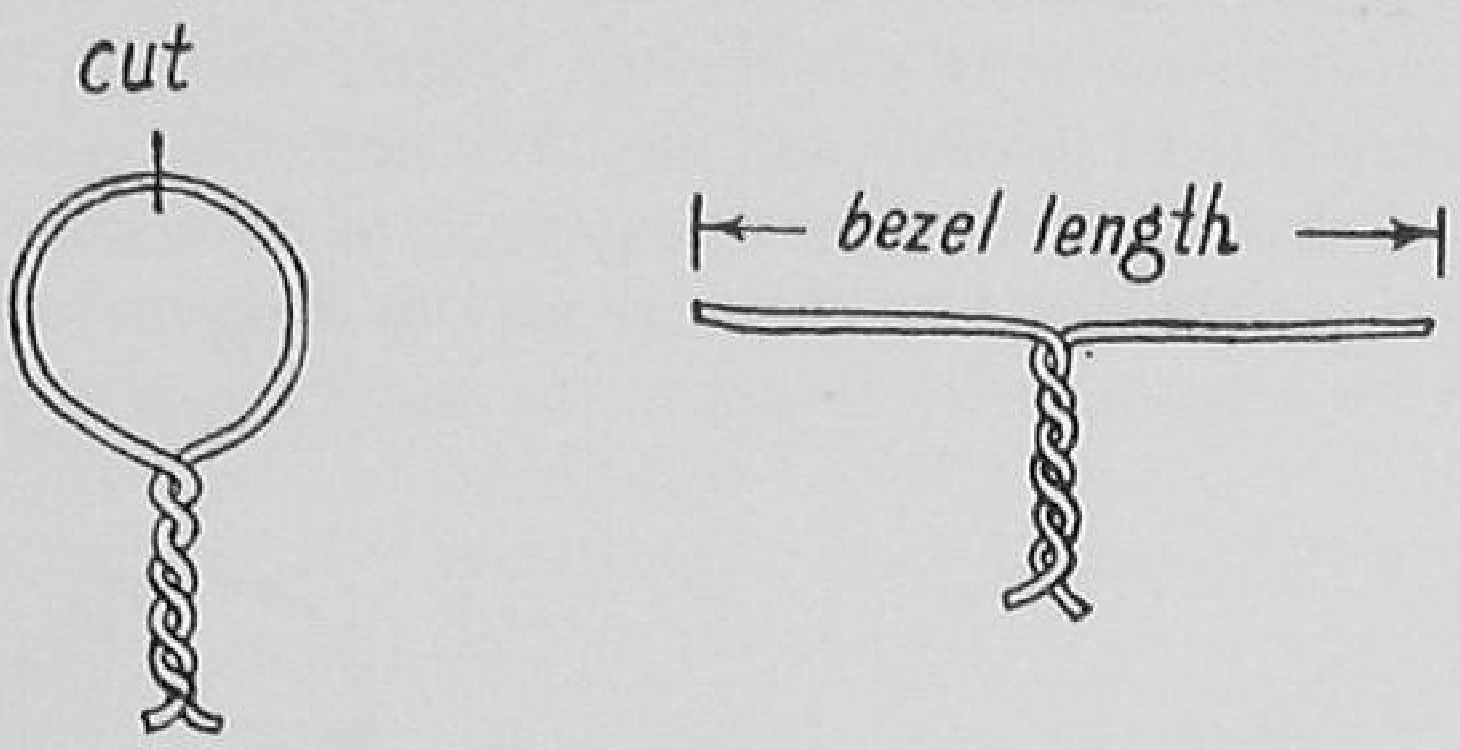


FIG. 55.

diameter cannot be reduced without resoldering, but a bezel that is *slightly* undersize can be stretched by hammering it carefully over a mandrel, using a flat, polished hammer. When only shaping is necessary, hammer the bezel on a mandrel with a rawhide mallet. A square bezel may be bent with flat, accurate pliers (pp. 508-509) or by carefully hammering the square corners over a square steel mandrel. The stone must be able to fit into the bezel from either side. A tapered mandrel will tend to form a tapering bezel. To avoid this, reverse the position of the bezel frequently on the mandrel while hammering, or use a cylindrical mandrel, such as round steel rod.

The Inner Bearing.

The round inner bearing for a bezel may be made after determining the length needed to fit the inner circumference of the bezel. Square or round wire of No. 20 or No. 18 gauge may be used. The bearing is shaped to fit the inside of the bezel, and the ends are then soldered, employing a technique similar to that used in soldering the bezel. The two "rings" are then assembled, and, if the fit is correct, the inner bearing is set at an appropriate level inside the bezel, with the soldered joint opposite that of the bezel. A loop of fine binding wire may be run once around the bezel and its ends twisted. This will prevent the bezel from opening. The two

"rings" may then be bound together with light binding wire, twisted in place at three different points. Cover the two joints with flux, run additional flux around the bearing inside the bezel, and space a few tiny squares of hard solder inside the bezel. Place the unit on a charcoal block, apply a gentle, blue flame to dry the flux, and continue until the solder flows. Remove binding wire and pickle. If too much solder has been used, the top of the bearing surface may not present a clean right angle at the junction of bearing surface and bezel wall. The stone, therefore, may not rest evenly on the bearing. Remove any excess solder with a three-cornered hand scraper or a cylindrical, flat-bottomed burr, mounted in a sensitive drill. The use of round wire as an inner bearing will eliminate the aforementioned difficulty.

The square inner bearing may be made of square wire. In order to achieve a clean right angle, bend at each corner. The corners are mitered, as shown in Fig. 56. Before filing the miters, the proper length of each

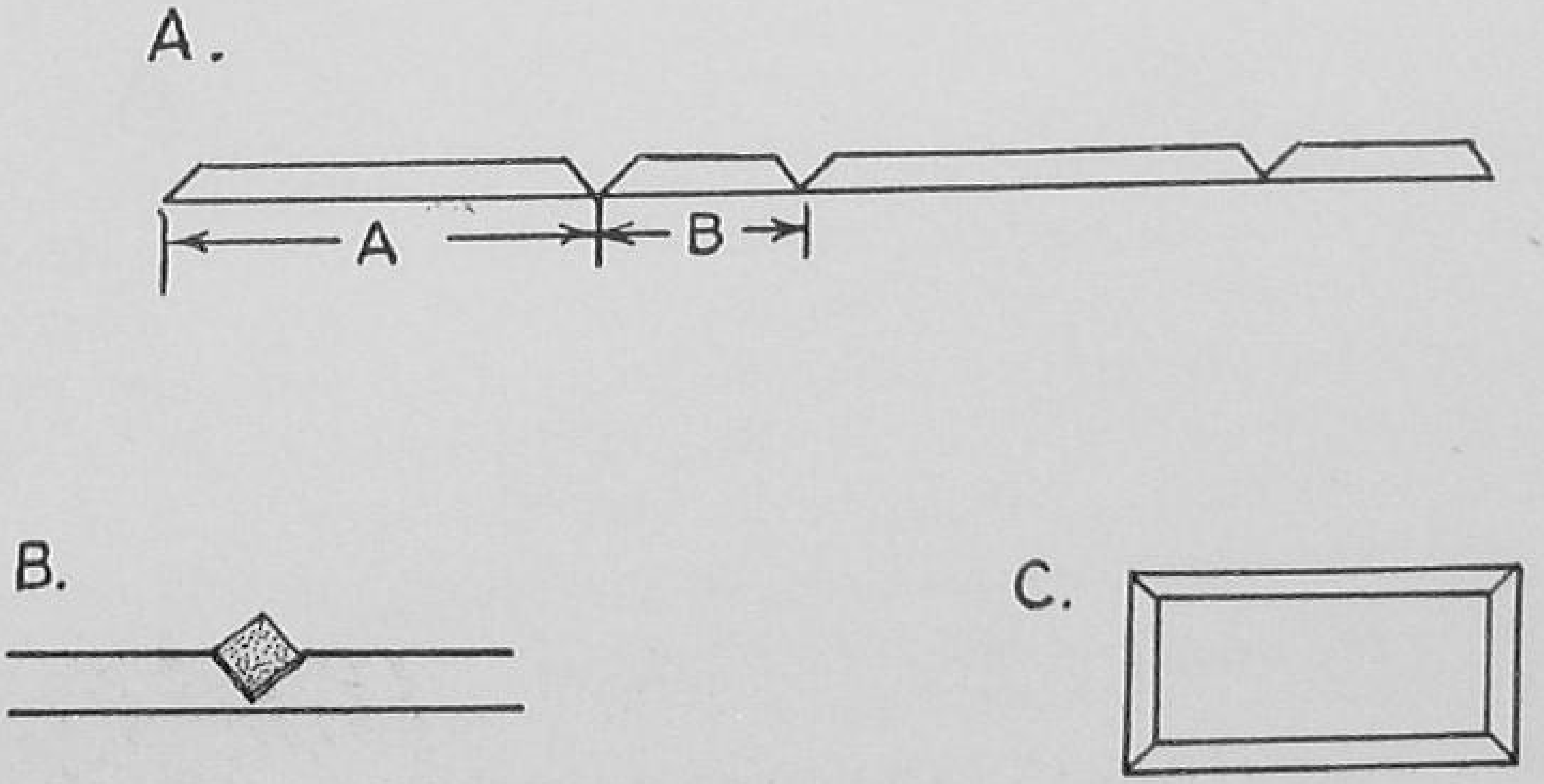


Fig. 56.

side must be marked off with a scriber. Fig. 56 shows a rectangular inner bearing. Side *A* equals the inside length of the long side of the rectangle. Side *B* is the inside length of the short side of the rectangle. At each mark, on the opposite surface, a V is cut for the miter. A needle file having a square cross section is used, since the corner of the file will cut a 90 degree V. Note in the diagram, at *B*, how the file lies in the cut. The depth of the cut should be about three quarters of the way through. The bearing may then be bent to fit inside the completed bezel. If the corner seems to "pucker" slightly, and leaves a bump on the bearing surface, file the bump

down flat. Loop a piece of binding wire around the bezel to secure the joint, or touch it over with loam, and apply flux at each corner of the mitered bearing. Put a piece of solder at each corner of the bezel and apply the torch. Heat each corner so that the solder seals the miter and also unites the bezel to the inner bearing. Remove wire, pickle, and clean up bearing surface if necessary.

An Alternate Bezel and Bearing Method.

A bezel of any form—rounded or angular—may be made together with the inner bearing, if reasonable care is taken. Refer to Fig. 57. The strip for the bezel is measured and cut in the usual way. A strip of sterling may then be cut (No. 22 gauge will do) and placed over the bezel strip, as shown. Both pieces should lie perfectly flat. A rawhide mallet used *gently* will help flatten the metal. Flux and clipped solder are now applied. The two pieces are hard-soldered and then pickled. The narrow strip provides

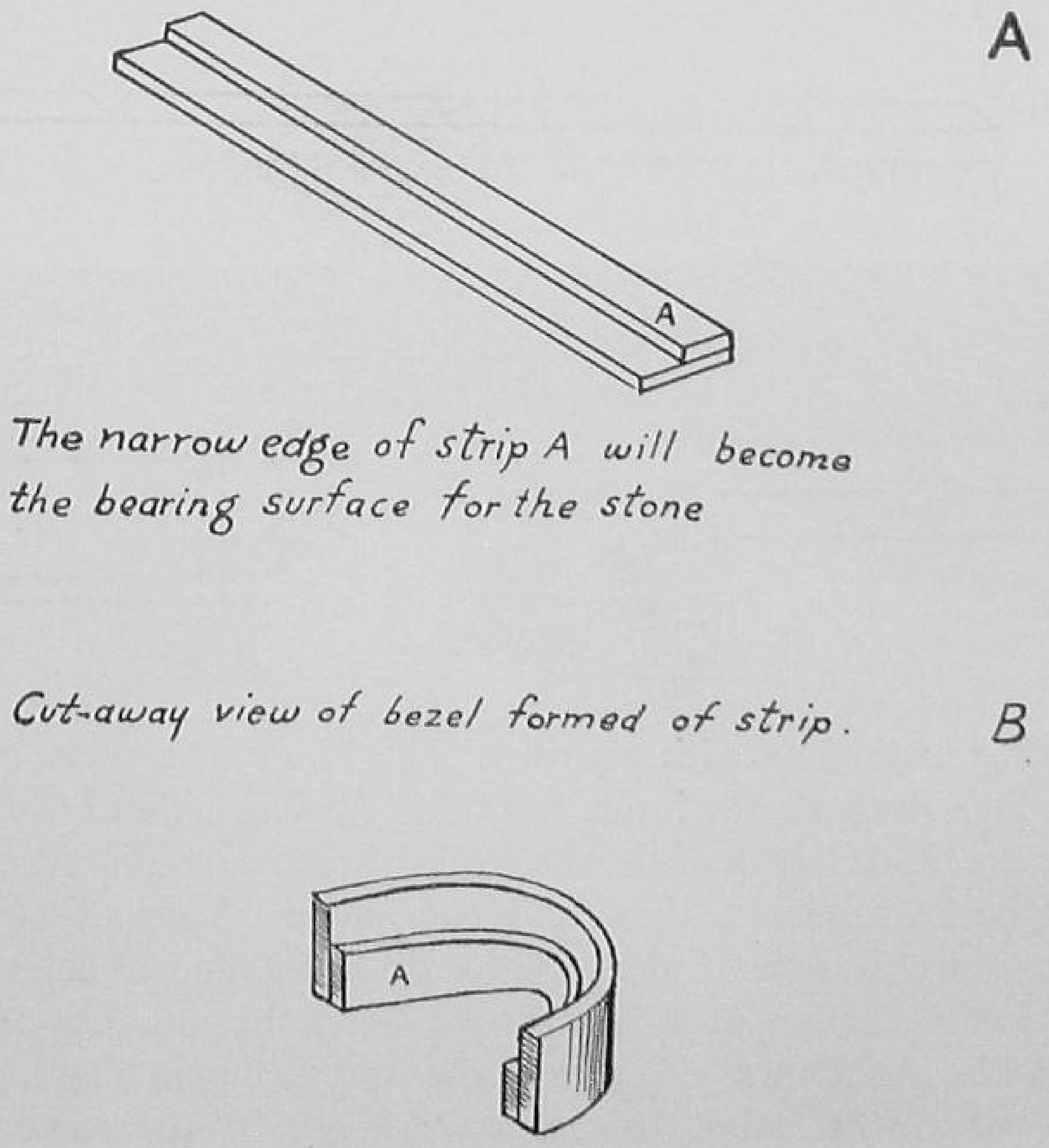


FIG. 57.

the inner bearing surface. Bend the bezel to shape, remembering not to judge the inside diameter from the *bearing wall* but from the inner *bezel wall*. The two ends should meet, showing no light. Solder as described in the section on bezel soldering. If a square or rectangular bezel is being made, lay off the sides with a scriber, and file through the piece comprising the *bearing*. Use a square needle file, as previously described. Bend the notched strip to form the complete bezel and bearing. Tie with binding wire. Apply flux and a piece of solder inside each corner and heat until solder flows. Remove wire and pickle. Clean the bearing surface with scraper or burr, if necessary.

Setting the Stone.

The stone is never set until *all* heating and chemical treatments have been completed. Sometimes the polishing may be completed before the stone is set, but, if the setting is of a delicate type, avoid polishing it until the stone is set.

The Burnisher.

The burnisher is held as shown in Fig. 58. The jewelry may be held in the fingers. A ring may be held in a ring clamp. The bezel edge is turned

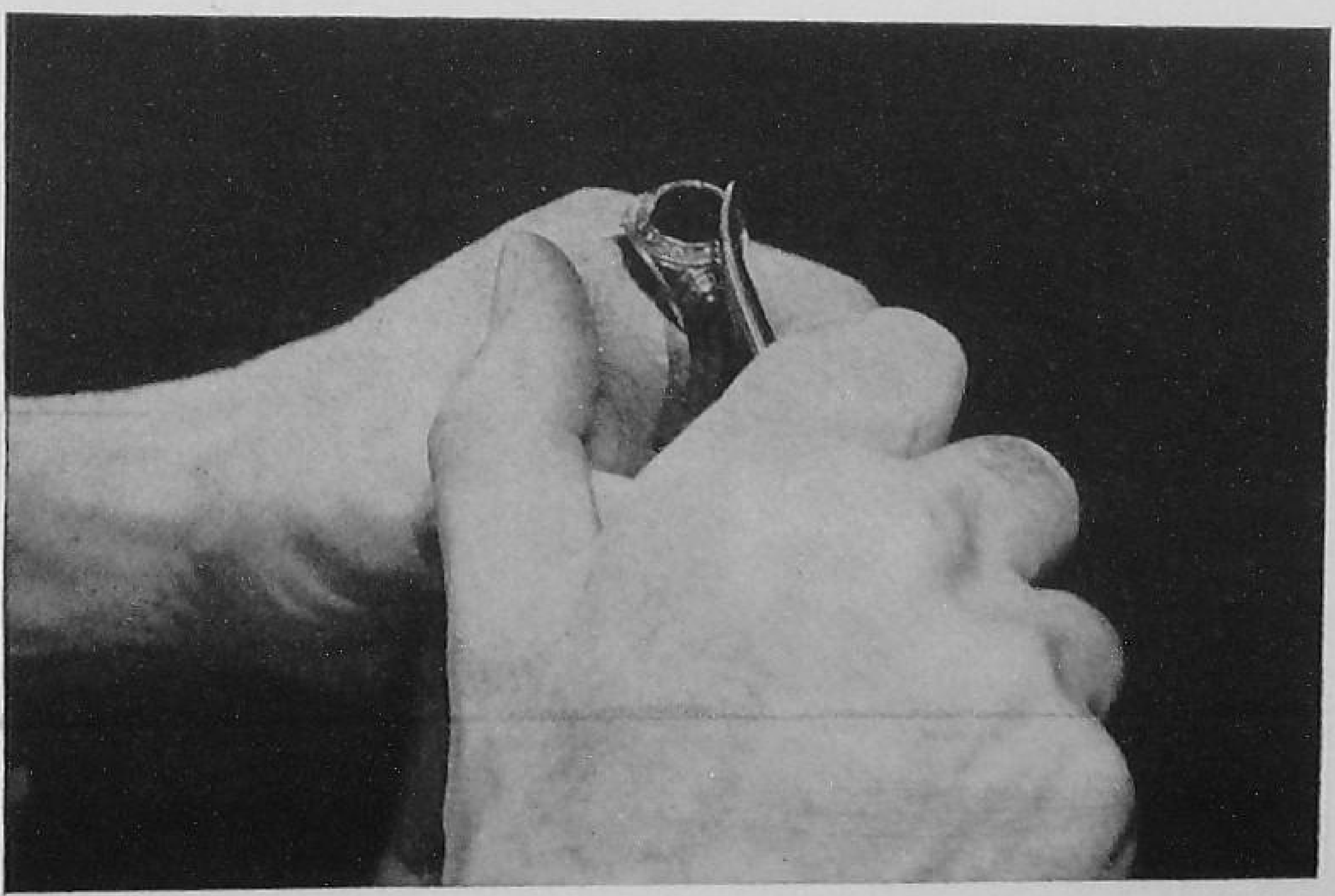


Fig. 58. Burnishing a bezel.

in lightly at first. Pressure is then increased until the bezel hugs the stone tightly. If the burnisher does not seem to move smoothly over the bezel, the surface of one or the other may need to be cleaned. If cleaning does not solve the problem, moisten the burnisher with soapy water before using. It is *imperative* that the burnisher be wiped thoroughly dry when its work is completed in order to safeguard the highly polished surface.

The Setting Tool.

Sometimes a stubborn bezel or prong will not turn in under pressure of the burnisher. A stone setting tool is then used. This tool is similar to a chasing tool of square cross section, with the end ground off flat. Mount the ring in a ring clamp, which may be set in a vise. Hold the flat end of the setting tool against the bezel or prong. Tap the top of the tool *lightly* with the flat face of a chasing hammer. Do this at four opposing points, and then completely around the bezel. Follow this with the burnisher. If the setting tool has left any marks, remove them with a very fine file or a Scotch stone before burnishing. If the stone is being set in a piece of flat jewelry, the piece may be temporarily held on a shellac stick or in a pitch pan, until the use of the setting tool is no longer necessary. A shellac stick may be made by joining a piece of ¼″ plywood, measuring about 1½″ x 2″ to a piece of ¾″ or 1″ dowel (see Fig. 59). Use two long brads to fasten the two pieces together. Melt a mixture of ½ flake shellac and ½ sealing wax over the top of the plywood to a depth of about ⅛″. Warm the shellac compound to mount a piece of flat work, as well as to remove it. When necessary, any small bits of shellac that may adhere to work are removable by washing with alcohol.

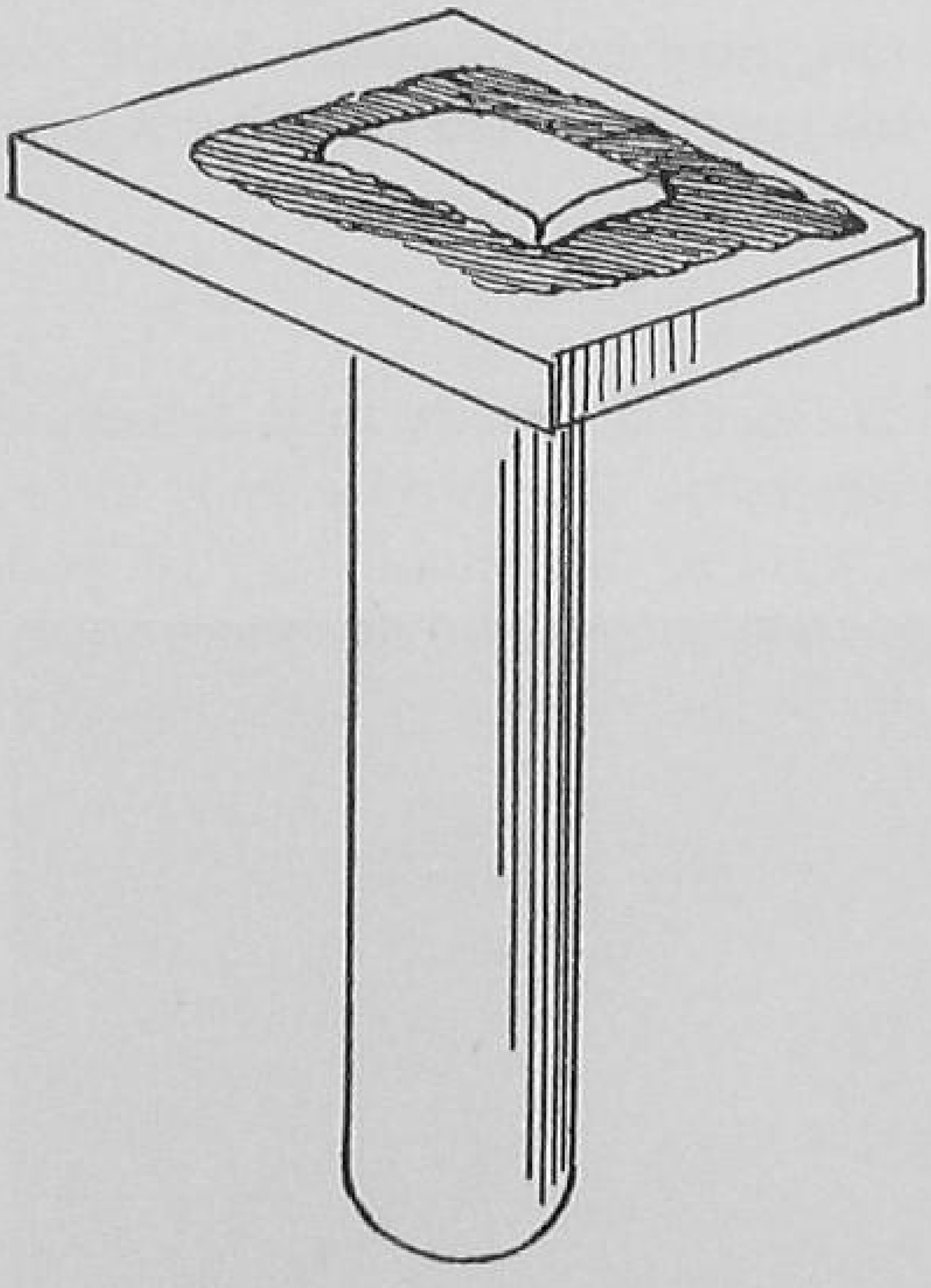


FIG. 59.

A small-diameter dowel tipped with the shellac or pitch compound may be used to lift a small stone out of a bezel. This is sometimes necessary

when a stone is placed in a bezel if its size is to be checked, since the smooth surface of the stone makes grasping with the fingers difficult.

The Bezel Backing.

When transparent or translucent stones are used in a piece of jewelry, a portion of metal behind the stone and inside the bezel area is usually removed. This piercing, whose purpose is to allow the passage of light through the stone, is done with the jeweler's saw, except in the case of tiny settings, where a small drill may be used. The metal is removed, when possible, after the bezel has been soldered in place. If the design of the piece makes this impossible, the area to be removed under the setting must be carefully figured out beforehand and then cut.

On many pieces of jewelry using opaque stones, metal is removed in back of the stone to reduce the weight of the piece. A brooch that is too heavy will hang awkwardly. Also, in the case of precious metals, material may be saved by removing unnecessary metal.

Fitting a Bezel to a Curved Surface.

When it is necessary to fit a bezel to a curved surface, as in a bracelet or a ring, the following is the procedure:

The bezel is assembled in the usual way but allowance must be made for the contour of the curved backing when calculating the width of the bezel band. Refer to Fig. 60. View *A* shows the position of the stone on its

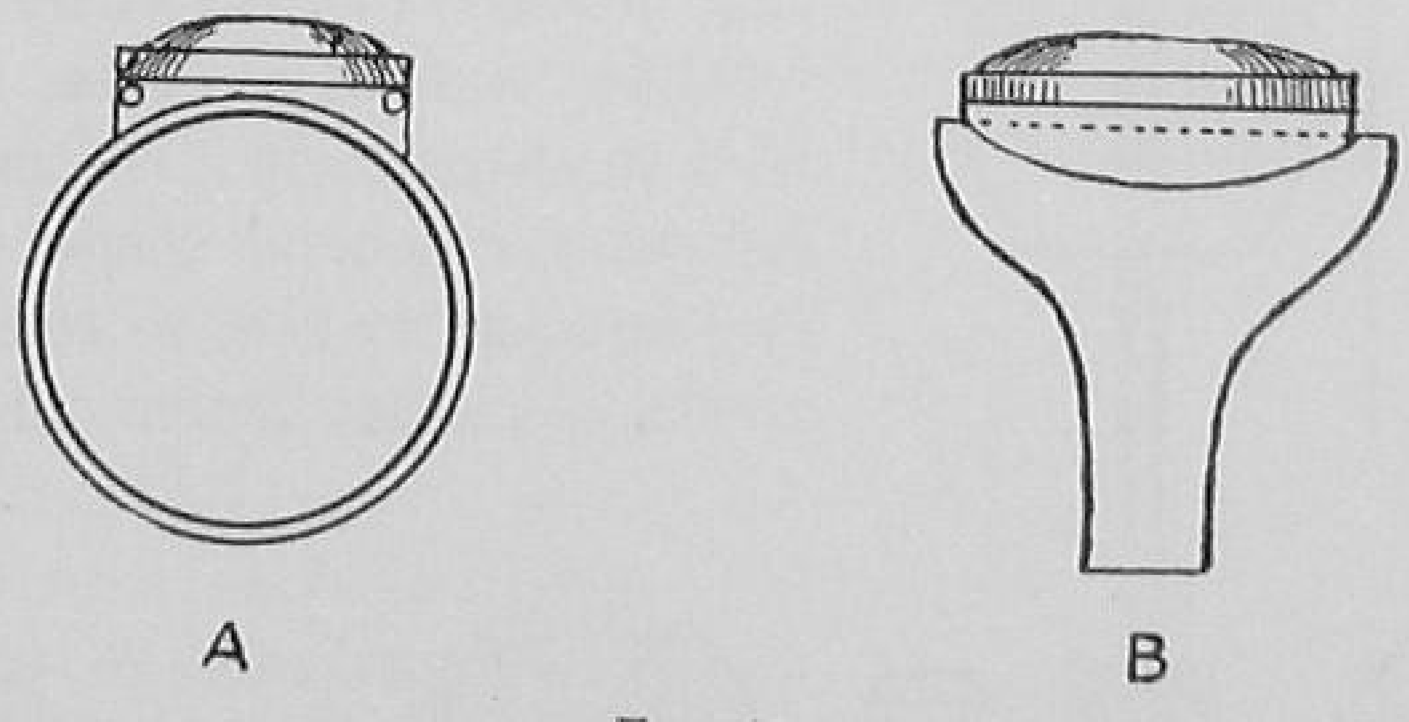


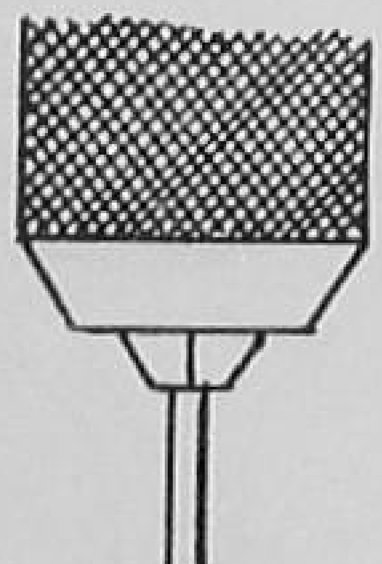
FIG. 60.

bearing surface. The back of the stone must clear the curve of the ring below. The appearance of the fitted bezel is shown in a side view at *B*. To fit the completed bezel to the curved object, a half-round file may be used. Check the progress of the curve frequently. No light will show when a job is properly fitted.

A simple way to secure a well-fitted bezel on a ring involves the use of a mandrel. Place a piece of No. 0 emery cloth over the mandrel at the portion equaling the ring curve. The abrasive side of the cloth faces upward. Rub the bezel carefully over this, along the proper axis if the bezel is not a perfect square or circle, until the curve is made to fit the ring. To save time, start the curve with a small half-round file and finish by rubbing on the emery-faced mandrel. Reverse the position of the bezel regularly during the rubbing process to compensate for the taper of the ring mandrel. Rub until a perfect fit is obtained but be careful not to go past the inner bearing.

Claw, or Prong, Settings.

A type of setting usually reserved for faceted stones utilizes small projections of metal, spaced at intervals around the circumference, to hold the stone in place. Such settings are known as claw, or prong, settings. They are very commonly seen on commercial rings, where they frequently hold diamonds. Obviously, then, such a setting, properly made, is quite serviceable. The advantage of such a setting is that it exposes as much of the gem as is possible. This exposure is not so much ostentation as it is intelligent workmanship. Such a setting permits light to strike the many facets that are cut on the *bottom* of the stone as well as on the top, resulting in a brilliance unattainable by walled-in-settings.



The drawing (Fig. 61) shows a cast ring in several stages of preparation for receiving a faceted stone. The ring is filed to shape as in *A*. The top surface follows the general shape of the stone and is equal in size to the stone at its girdle. At exact center a hole is bored

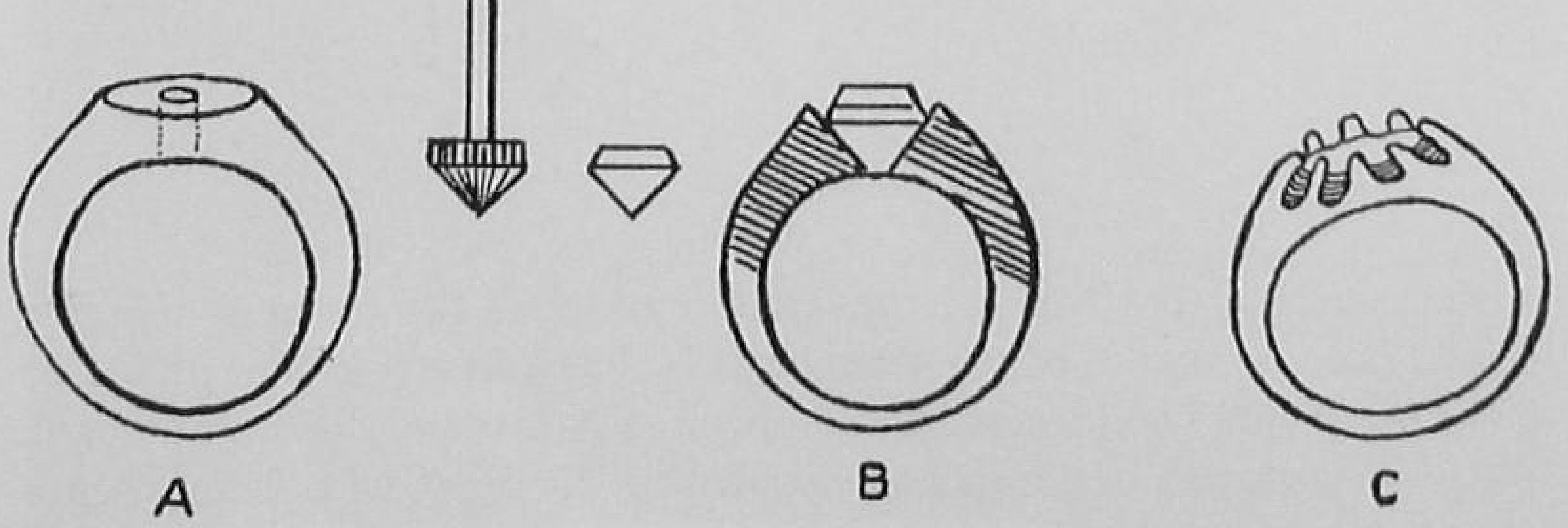


FIG. 61.

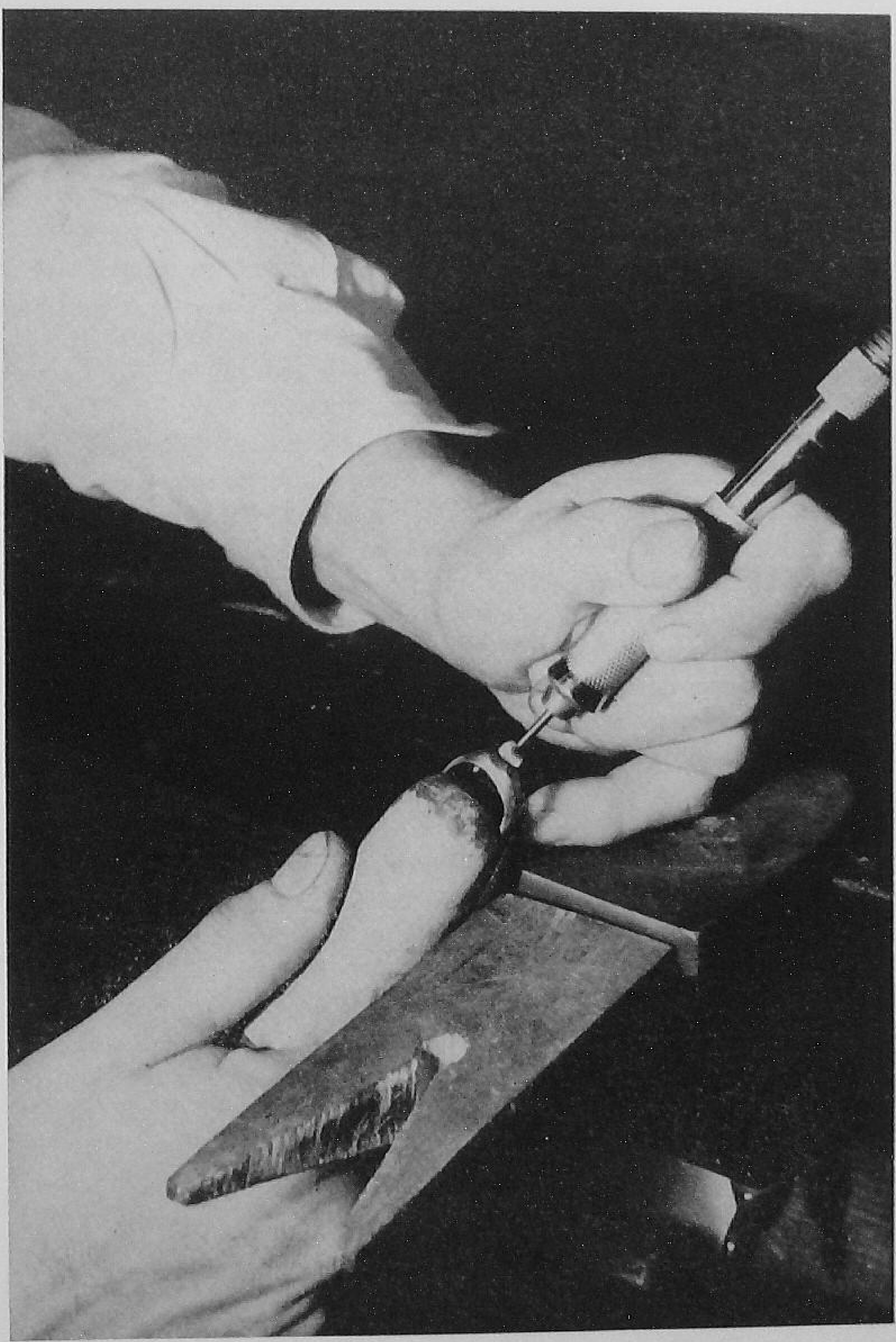


FIG. 62. Using the burr in a flexible shaft machine.

through the ring. The drill should be somewhat smaller than the stone. At this point the grooves are cut that form the separate claws. It is wise to paint the top portion of the ring with a machinist's blue layout stain in order to carefully scribe the outline of the prongs before filing. Use needle files to form the prongs. The tiny rattail or circular file cuts the grooves or channels. Be careful to avoid cutting away the tops of the prongs, thus making the setting too wide for the stone.

When the prongs are fairly well formed, a burr of the proper size is inserted in a hand drill or sensitive drill (Fig. 62). The ring is held in a vise, protected by copper or wood cheeks. If a sensitive drill is used, a small drill press vise may hold the ring. Bore into the hole in the ring with the burr to form a seat for the stone. Note that the burr will cut a straight-walled section on the upper part of the prongs. The rest of the seating will follow the angle of the bottom of the stone. Test for fit. When the stone fits the setting with the girdle or widest rim *very slightly* below the tops of the prongs, the seat is of correct size. Finish off the prongs carefully, filing them thin on top without removing any length. Check again with the stone. If satisfactory, clean up the prongs with a very fine abrasive paper or cloth and *carefully* polish them. Now set the stone, turning the thin-filed prong tops down over the stone with a burnisher. Turn down one prong, then the prong directly *opposite,* etc. Carefully finish polishing the entire ring, wash with soapy water, blow dry, and use polishing chamois skin.

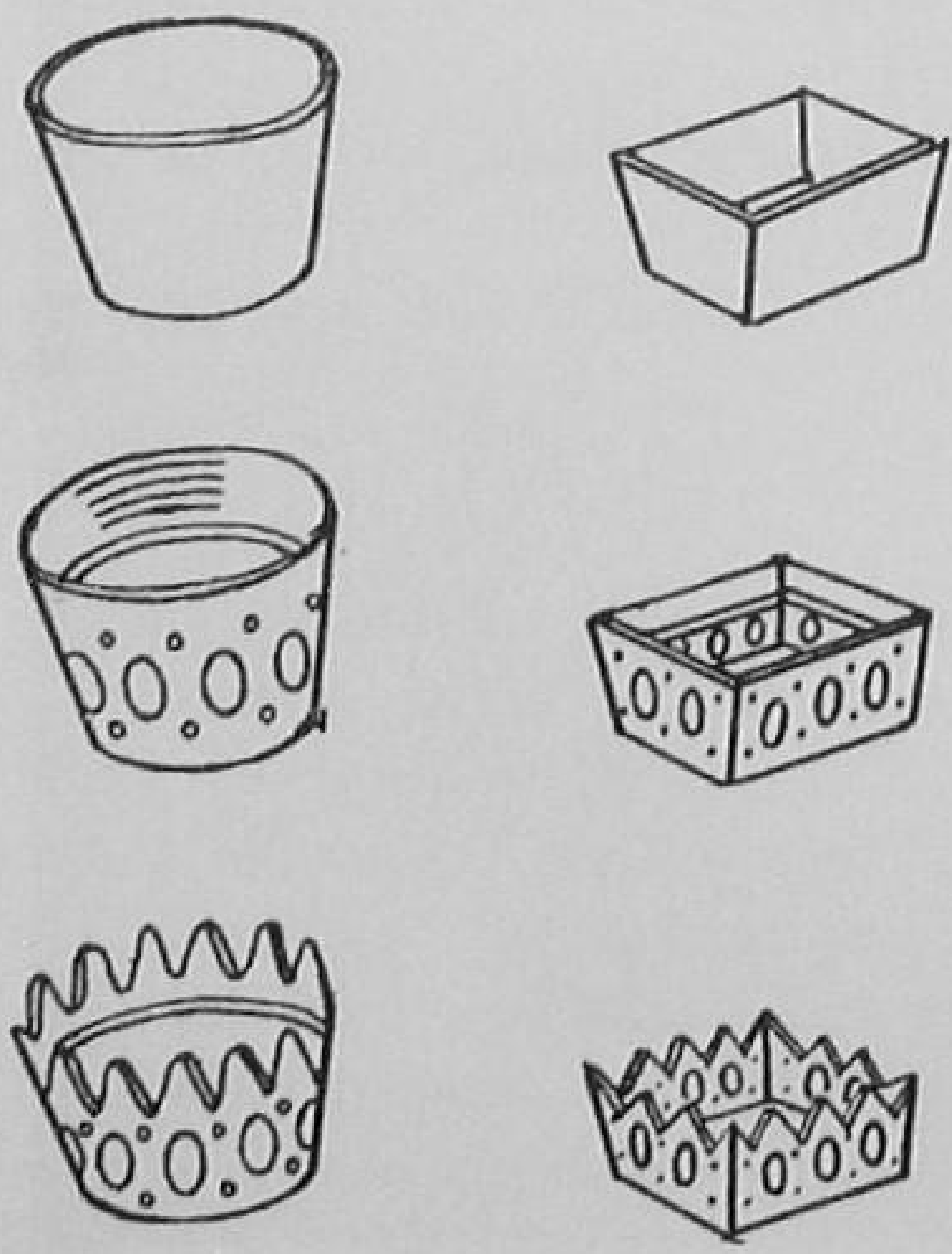


Fig. 63.

Note: The stone must *not* be set in such a way as to permit the point at the stone's base to extend through the ring, touching the wearer's finger.

Claw Settings of Sheet Metal.

When rings are built up of sheet metal and wire, decorative claw settings that form an integral part of the design may be used. Such settings are well adapted to faceted stone usage.

The diagrams in Fig. 63 show such settings in the round and rectangular forms. A small, *tapering* bezel is formed. The slope of the taper is not

nearly as extreme, however, as the base of the stone. The height of the bezel should be slightly more than the height of the stone from the point at the base to the girdle. The gauge of the metal used depends upon the size of the stone. Such bezels are of somewhat heavier metal than "ring" or "collar" bezels. Weights up to No. 16 gauge may be used.

When the bezel is shaped and soldered, a series of holes may be laid out around its "waist." Saw piercing may be done but is difficult due to the cramped working space. Whittle a wooden dowel to a taper so as to accommodate the bezel. Slip the bezel over the wooden "mandrel" so formed and lightly center-punch wherever a hole is to be drilled. Place the wooden "mandrel" in a vise, with the bezel end extending horizontally, and drill at each center-punched mark.

When drilling has been completed, make an inner bearing out of No. 22 or 24 wire. This will support the stone just under its girdle and prevent it from canting in the setting. Set this inner ring in place. It should leave exposed enough of the upper bezel to allow for the prongs. Test for fit by placing the stone in the setting with the inner bearing in place. If satisfactory, hard-solder the bearing into the bezel.

Cover the exterior of the bezel with layout stain and mark out the claws or prongs. Make them all uniform and evenly spaced. File out the intervening spaces with a three-cornered needle file. File the claws carefully to reduce their thickness at the top, making it easier to burnish each claw over the stone. Continue to make the complete ring and, when all heating and polishing operations are completed, set the stone.

NOTE: Paper and glue may be used to make a "model" of the tapered bezel.

When a satisfactory size has been made, cut through the seam and use as a pattern for the metal bezel.

The "Gypsy" Setting.

Occasionally, a round stone of the cabochon type is set into the surface of a piece of metal without a bezel. This is done by boring or carving a recessed area in the metal. Such settings, when used, are generally found on cast rings. The top of such a ring is shaped so that it is similar to the base of the stone in shape, but just barely oversize. The outline of the stone is then scratched on top of the ring and a small hole bored through the center. A burr of the required size and having an obtuse point is used to bore out the recess (Fig. 64). The depth to which the boring is done depends on the curvature of the stone. If a high-domed stone is used, the

depth is somewhat greater than would be necessary for a shallow stone. In any case, the stone does not sink very deeply into the recess in this type of setting. The base of the stone is supported at the angle formed by the pointed portion of the burr. The stone is set with the setting tool, which is tapped with a chasing hammer in order to "upset" the rim of the recessed setting over the stone. All marks are then filed away and the metal gone over with a burnisher.

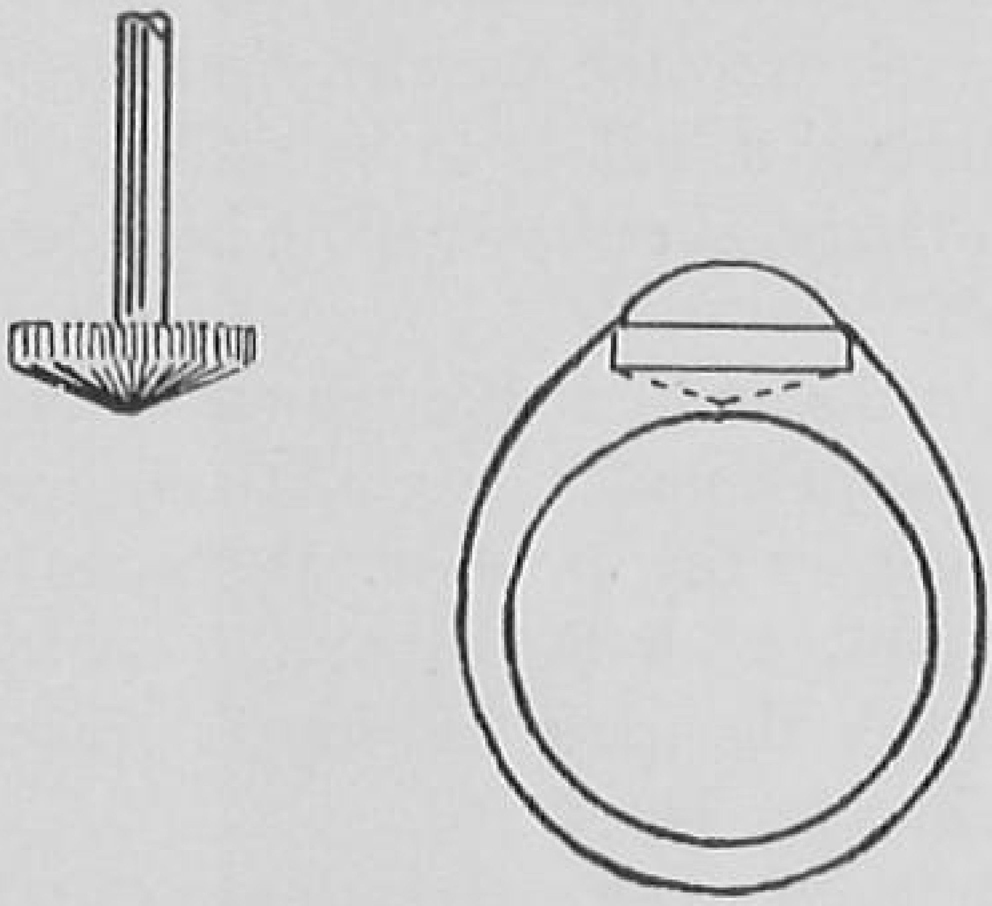


FIG. 64.

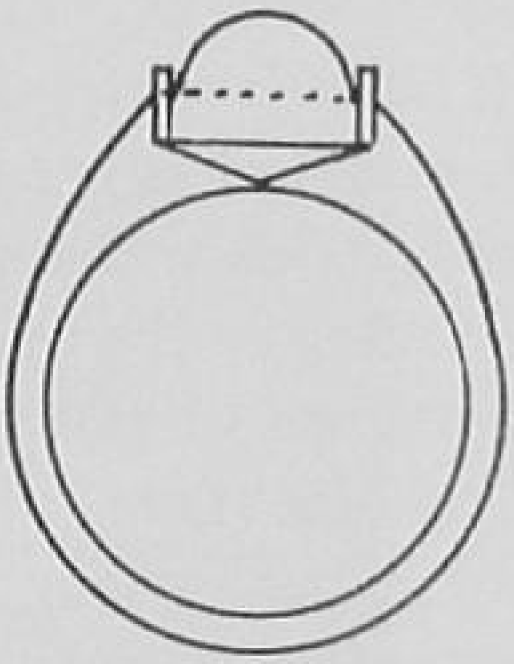


FIG. 65.

Sometimes a setting similar to the "gypsy" type is used with this difference: the recess is made larger than the girdle of the stone to the extent made necessary by an inserted bezel. The edge of the bezel extends very slightly above the top of the ring after it has been soldered into place. After the stone has been placed into its setting, this protruding rim is burnished over the stone (Fig. 65).

NOTE: When "gypsy" or similar settings are made on relatively thin gauge metals, the recess may be carved out by engraving tools instead of a burr. The outline of the recess is cut with a small "point" graver. The center of this setting may be removed by piercing, if a translucent or transparent stone is used.

Boring Holes in Stones.

Sometimes an ornament is to be mounted on the surface of a stone. The use of a cement is not workmanlike nor is it permanent. The best method is to hard-solder a tiny piece of tubing to the ornament. The tubing is then passed through a hole bored in the stone. The end of the tubing is permitted to extend slightly past the underside of the stone. It

is then "spread" or burnished over the underside of the stone, making a permanent union between stone and ornament.

Soft stones can be scratched with a file. Such stones may be drilled with a fine, high-speed twist drill or a dentist's drill. The drills should be used at high speeds and lubricated with turpentine at the point of drilling.

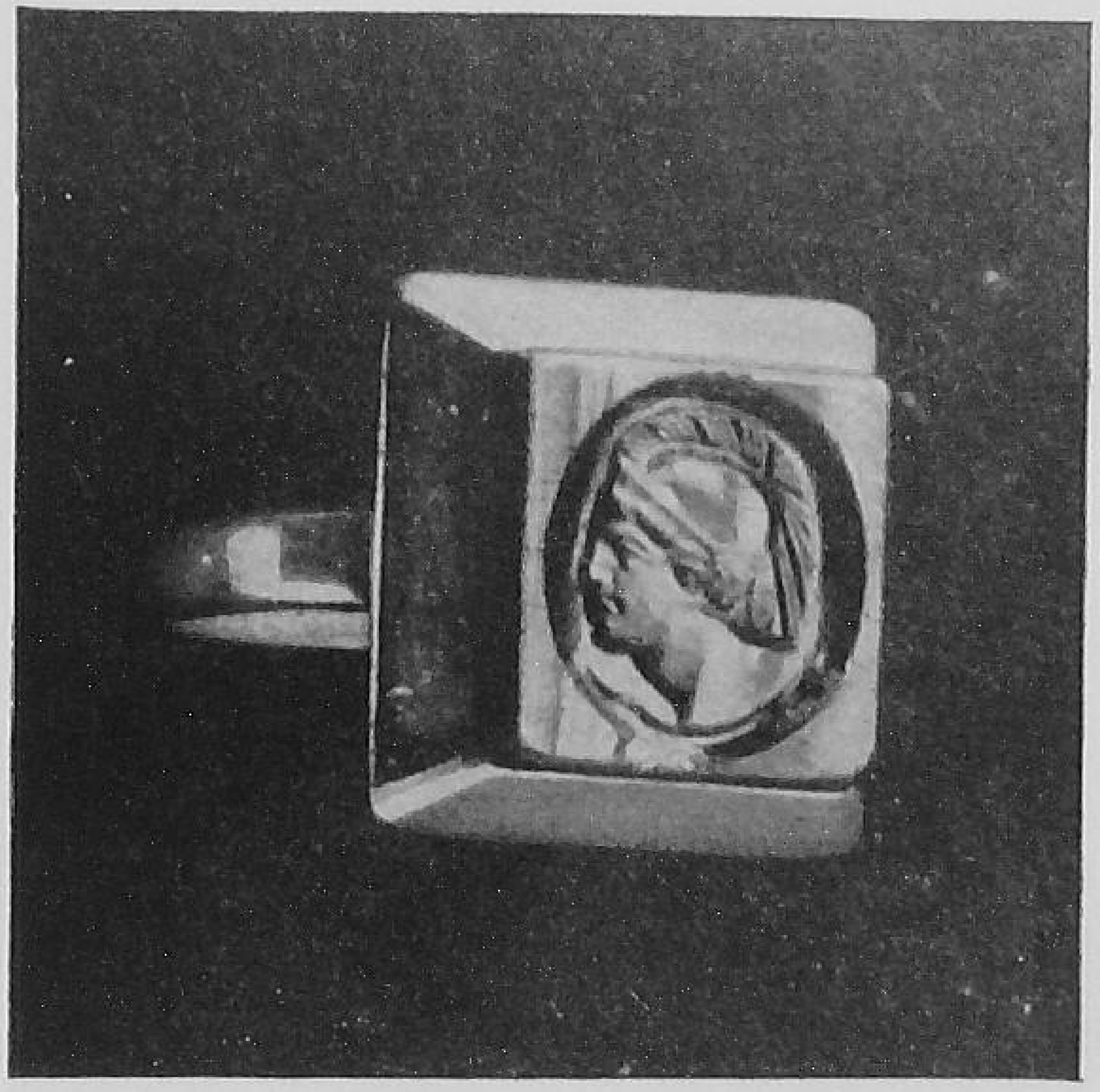


FIG. 66. This stone was set by expansion-fit, a rather precarious method. The opening for the stone is just slightly undersize. The ring is heated and the expanded opening pressed over the overturned stone.

Hard stones can be drilled with an improvised drill consisting of a piece of hollow tubing and an abrasive. The tubing selected need not be particularly hard, since it merely carries the cutting abrasive.

To use the tubing, "upset" it on its working end by slightly hammering it with a flat hammer squarely on its end. The end will thereby become slightly enlarged, permitting it to rotate freely in the hole it bores. The abrasive, into which the "drill" end is occasionally dipped, may be Norbide (Norton Abrasive Co.) or a silicon carbide grit of fine grain. The abrasive grit is mixed liberally with a bit of petroleum jelly. The resultant com-

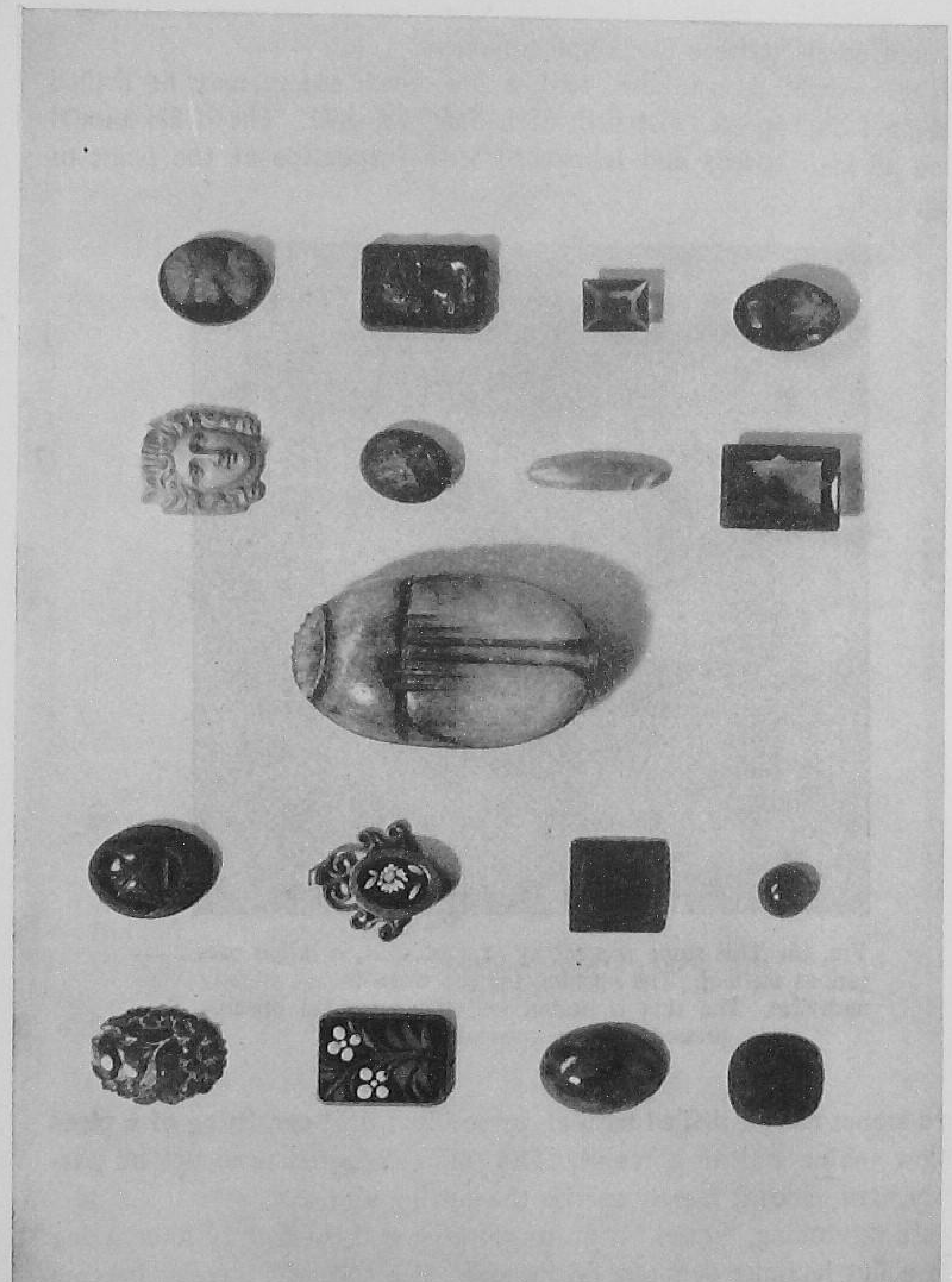


FIG. 67. *Top:* 1. Carved and pierced; 2. scarab; 3. head; 4. cameo. *Second Row:* 1. Flat, decorated; 2. Mosaic (Italian); 3. cameo; 4. chevee. *Large Center:* Scarab (Ivory). *Third Row:* 1. Oval Cabochan; 2. Flat top (square); 3. Cabochan (oval); 4. Cushion (faceted). *Fourth Row:* 1. Flat top; 2. Cabochan (round); 3. Cushion (faceted); 4. Oval faceted.

pound is applied to the end of the hollow "drill." Occasionally, add a bit of light lubricating oil while drilling. Use a high-speed sensitive drill. The size of the hole bored should equal the diameter of the tubing used for mounting the ornament. The stone may be held in place on a board during the boring operation with a drop of chaser's pitch or melted flake shellac. This method of boring is frequently used to bore holes in glass vessels.

Chapter XIV

WIRE WORKING

A supply of wire of different gauges should be kept in stock, since it provides an almost endless source of decorative or ornamental material. Wire need not be kept in all gauges if the worker wishes to make use of a draw plate. Wire should be kept in various shapes (cross-sectional), such as round, half-round, and square. Draw plates are again useful here, but a supply of the various wires will save much time and labor. Fancy "gallery" wire bears the same relation to jewelry work as wood molding does to the woodworker. Such wires are obtainable at the larger jewelry supply houses and are invaluable as decorative additions around stone settings, pin borders, etc.

Ordinary square and round wire have possibilities for decoration and construction which will be dealt with in the remainder of this chapter.

Twisting Wire.

Round wire may be twisted to obtain a variety of effects. The technique of twisting the wire is simple. A piece of wire twice the required length is bent at the center and doubled, yielding a double wire half the original length. Remember in computing the length to allow about an inch for waste. This waste is the somewhat distorted wire remaining at the ends of the finished twist. A hand drill is used as the twisting device for wires up to number 16 gauge. Beyond this gauge, it may be necessary to use a carpenter's brace or a spool and rod, as explained further on. A hook, such as a common cup hook, is inserted in the drill chuck. The two original wire ends, now side by side, are clamped tightly for a distance of approximately ½″ in the side of a vise. The loop formed at the other end, by doubling the wire, is caught on the cup hook. Hold the handle of the drill so as to keep the wire tautly horizontal, and turn the handle slowly, twisting the wire (Fig. 68). The best twists are fairly close, reaching a point where the resulting work loses the appearance of two wires and assumes a rope-like decorative effect. Too much twist, which can be felt as the wire resists the twisting, may snap the wire. If more than one

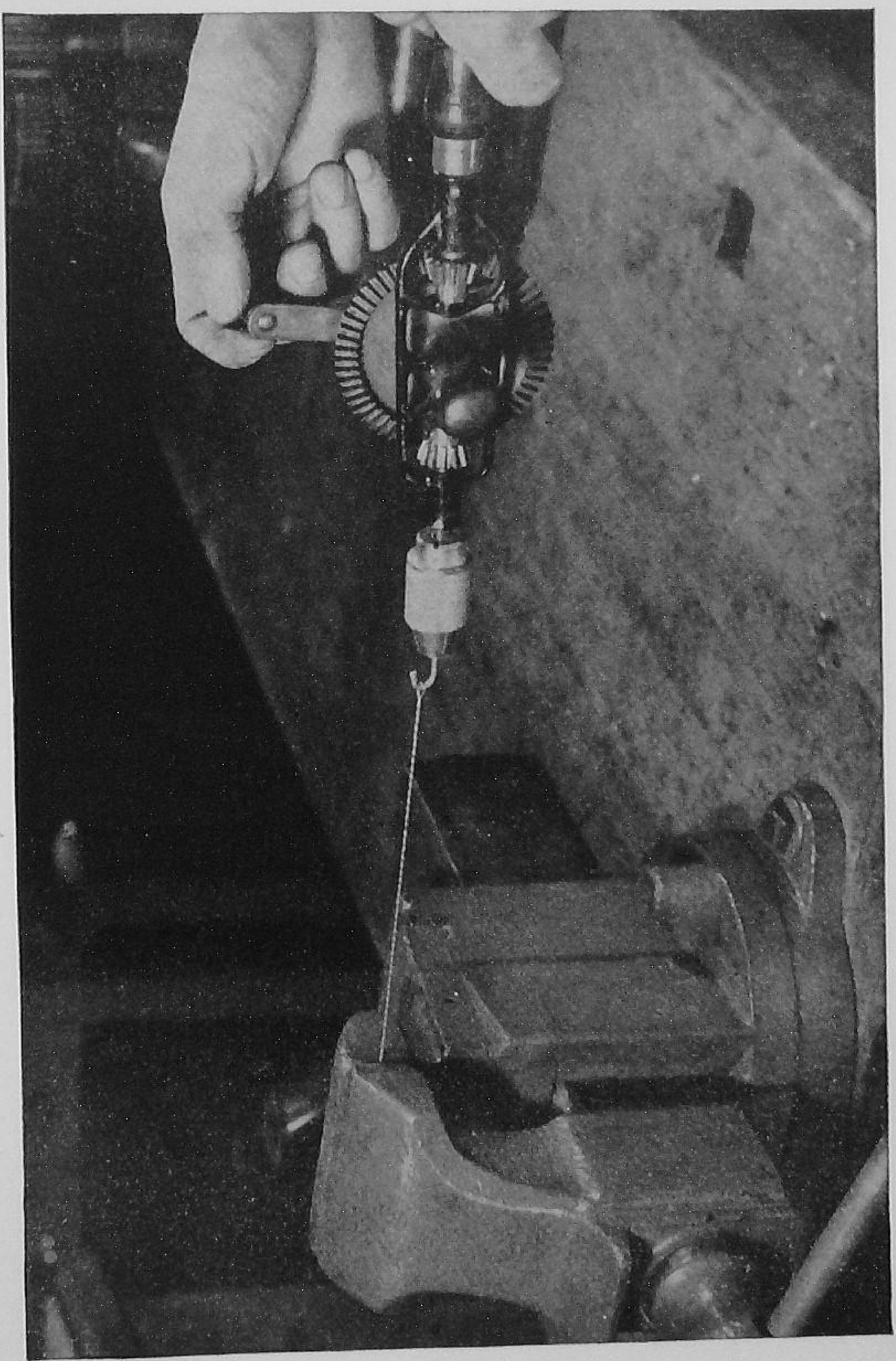


FIG. 68. Twisting wire with the aid of a hand-drill.

twisted length is to be used, side by side, remember the direction in which the drill was rotated. By reversing the next twisted length and laying it next to the first, a herring-bone effect is obtained. To twist heavy gauge wire, insert a heavier hook in the chuck of a carpenter's brace and work in a manner similar to the hand-drill technique. A spool and rod may be used for twisting light or heavy gauge wires. The wire is looped, as previously, clamped in the vise, and a spool is slipped over the doubled length. A slim rod of steel or iron, such as a long, heavy nail, is put through the loop. One end of the nail is left protruding as a turning handle. The spool is held snugly against the nail, keeping the wire taut (See Fig. 69).

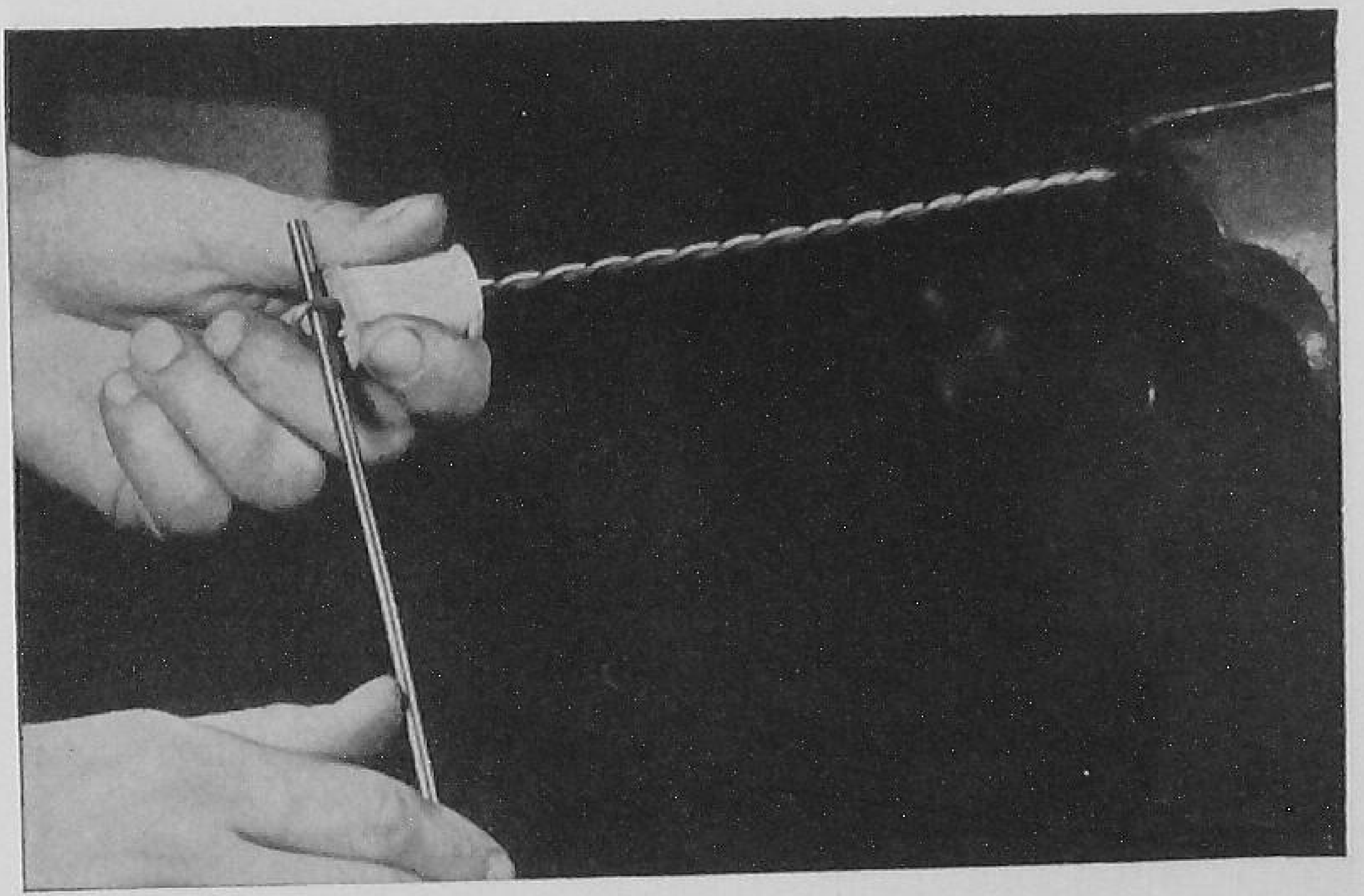


FIG. 69. Twisting heavy wire with rod and spool.

Further Processing the Wire.

Twisting the wire is only the first step in a series of decorative effects that may be obtained by further processing of the "twist." The twist may be hammered so as to flatten it on two sides. This is done with a polished flat hammer. The wire rests on a smooth steel plate. Excessive hammering will yield a thin, easily broken tracery of wire that is usable only as appliqué. Such work must be carefully annealed if it is to be bent, otherwise many fragments will result. A twist may also be rolled flat in the rolling mill. This yields an effect slightly different than that obtained by

hammering. The reason is that the rolling mill squeezes the metal ahead of the roller, resulting in a spiral having a lengthened appearance (Fig. 70).

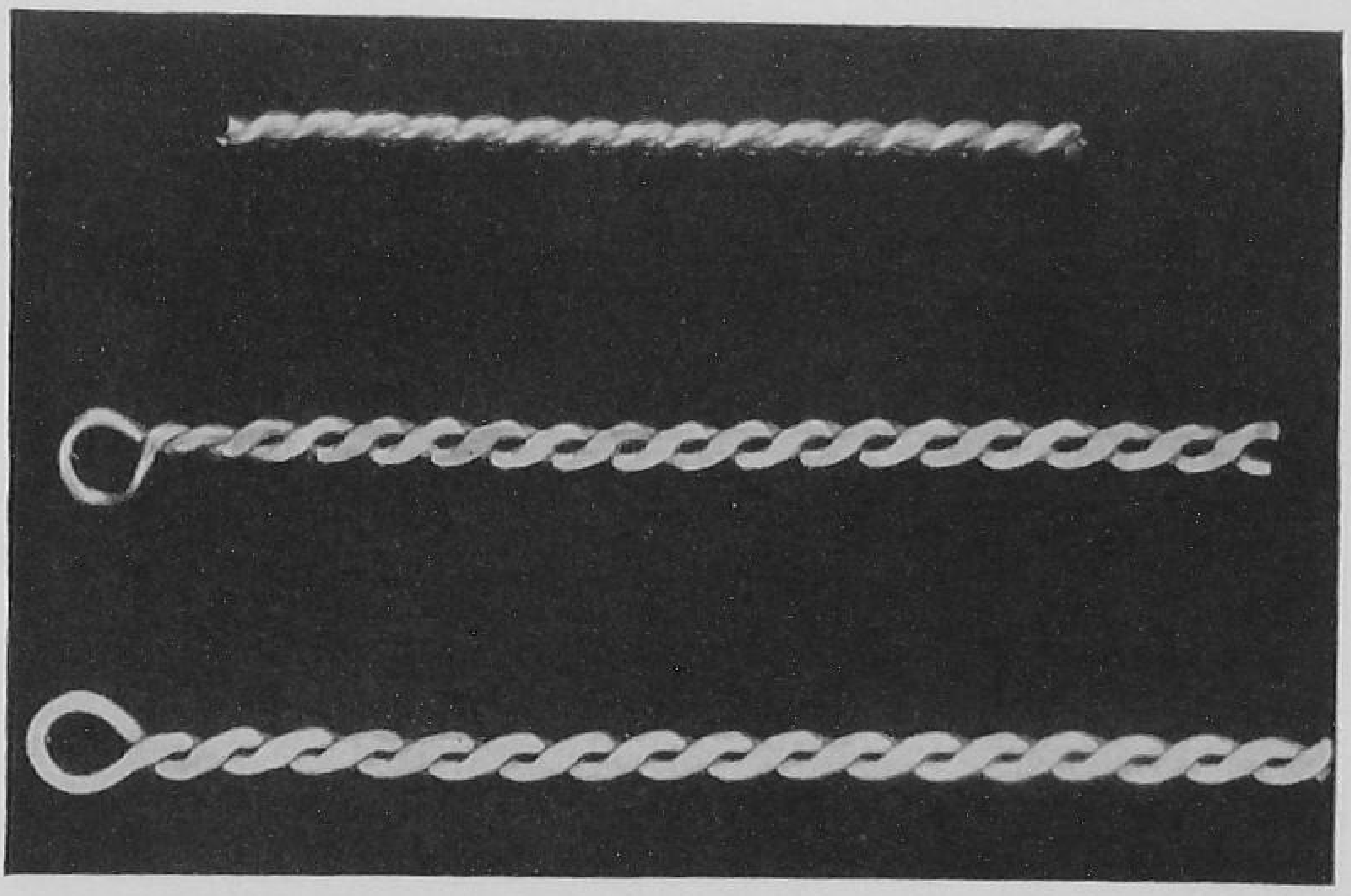


FIG. 70. (1) Twisted wire. (2) Hammered twist. (3) "Rolled" twist.

When hammering a "twist," the flattening effect is to be obtained gradually, working back and forth along the length of the wire. If heavy gauge wire is being worked, anneal occasionally to avoid breakage. Also anneal before forming a circle for a bracelet. The breakage is caused by the fact that the twisted wires cross over each other. When they are hammered, the wires cut into each other, forming many possible points of breakage. Frequent annealing will eliminate the brittleness and consequently the breakage.

Squaring the Wire.

When wire from 6 to 10 gauge is used, it may be hammered square after twisting. This is done by hammering on a steel plate to form the two opposite flat sides. Do not hammer very flat at this point, but turn the work as soon as flats appear. The remaining two sides are then hammered. Anneal and work carefully over all four surfaces until a perfectly square

cross section results. When this is done, the result is an excellent material for forming bracelets, cuff-links, earrings, and brooches (see Fig. 15).

The Draw Plate and Twists.

"Twists" may be drawn through various types of draw plates so as to obtain square, oval, or half-round effects. Remember to anneal frequently. A tendency of the wire to separate at the ends may be overcome by hard-soldering the end of the twist to be fed into the draw-plate hole. This end is then easily filed to a point and threaded through the plate holes. Twisted wire drawn through the common round-hole draw plate results in a twist of an entirely different character.

Triple Twists.

A length of wire may be divided into thirds and folded, making a three-strand piece. Such a length of wire may be clamped in a vise but, if difficulty is encountered in keeping three ends in the drill chuck (no hook is used), solder the chuck end of the wire for a distance of approximately ¼″.

This twist is quite decorative and may be treated by hammering or drawing, yielding a fine material for bracelets and finger rings. Such a

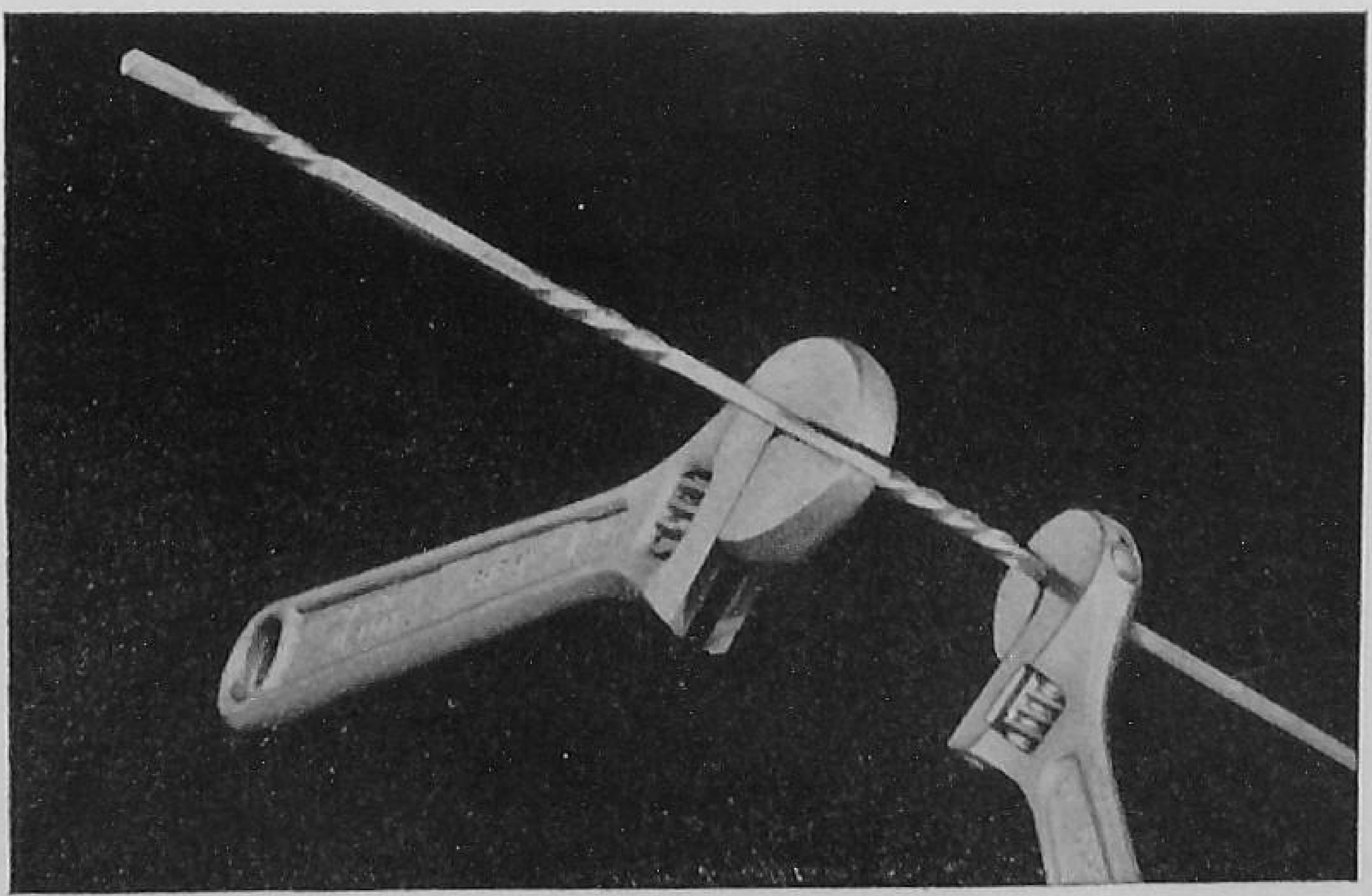


FIG. 71. Twisted sections of square wire.

twist, bordered on each side with a slightly heavier length of square wire, will produce a lovely finger ring or bar pin.

Single Wire Twists.

Wire having a rectangular or square cross section can be twisted to good effect, without doubling the length. The method is similar to that used for other twists. The sample in the photo, showing alternate twist and plain sections, was made by using a pair of small open-end adjustable wrenches as shown in Fig. 71.

Joining Ends on Twist Circles.

When twists are used to form rings or bracelets, the ends to be joined must be matched so as to hide the location of the joint. To do this, saw

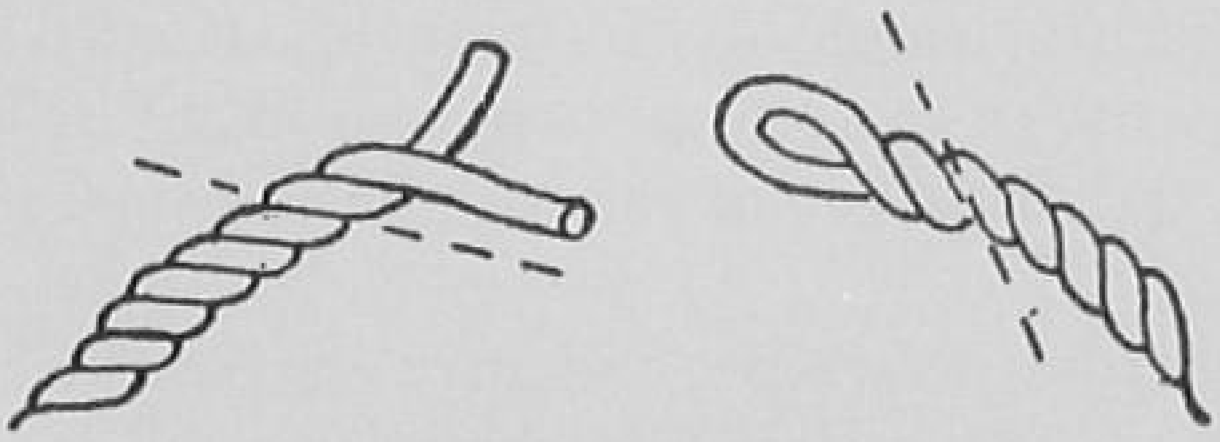


FIG. 72.

off the waste ends as shown in the sketch, Fig. 72, after which the ends may be joined by hard-soldering. Wire solder is useful for this type of work (Fig. 15).

Final touching up of the joint with a needle file will result in a joint difficult to detect even upon close examination.

Links and Chains.

Chains can be made of silver wire, for use as bracelets or necklaces. While chain is available in commercial form for holding pendant jewelry, much more imaginative chain can be fabricated by making a study of the many possible link forms that can be combined to make up a chain.

Simple circular links can be made by winding a close coil of wire around a rod-like mandrel, such as a heavy nail. The diameter of the mandrel will determine the size of the link. The shape of the link may be varied by utilizing mandrels of various cross-sectional shapes.

In order to insure a tightly wound coil, some workers utilize the following method: A narrow slot is made in the end of the mandrel to be used or a hole may be drilled in its stead. The wire coil is started by inserting

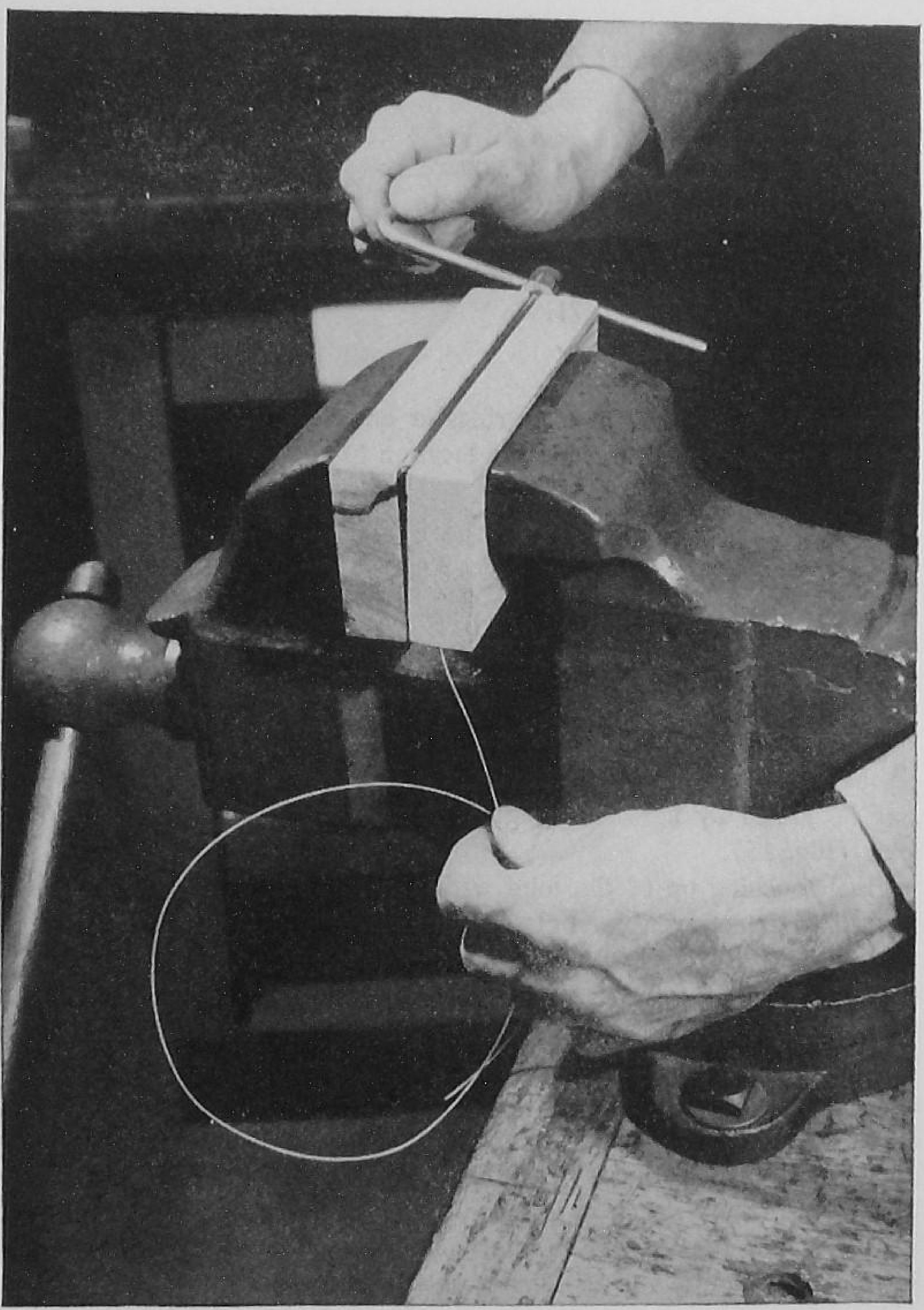


FIG. 73. A "jig" for coiling wire for links.

the end of the wire in the slot or the hole. A few tight turns are made and the started coil is then placed, together with the mandrel, between the wood-lined jaws of a vise. Moderate pressure is applied, and the mandrel is then rotated. The wire is fed on the mandrel from a coil or length hanging below the vise (Fig. 73). To rotate the mandrel, any one of several methods may be used. A carpenter's brace can be used by fitting the free end of the mandrel to the chuck. Another method involves the hard-soldering of a cross-piece to the end of the mandrel. The T-shaped device is easy to rotate by hand. The same results may be obtained by bending one end of the mandrel at right angles to the portion upon which the wire is being wound.

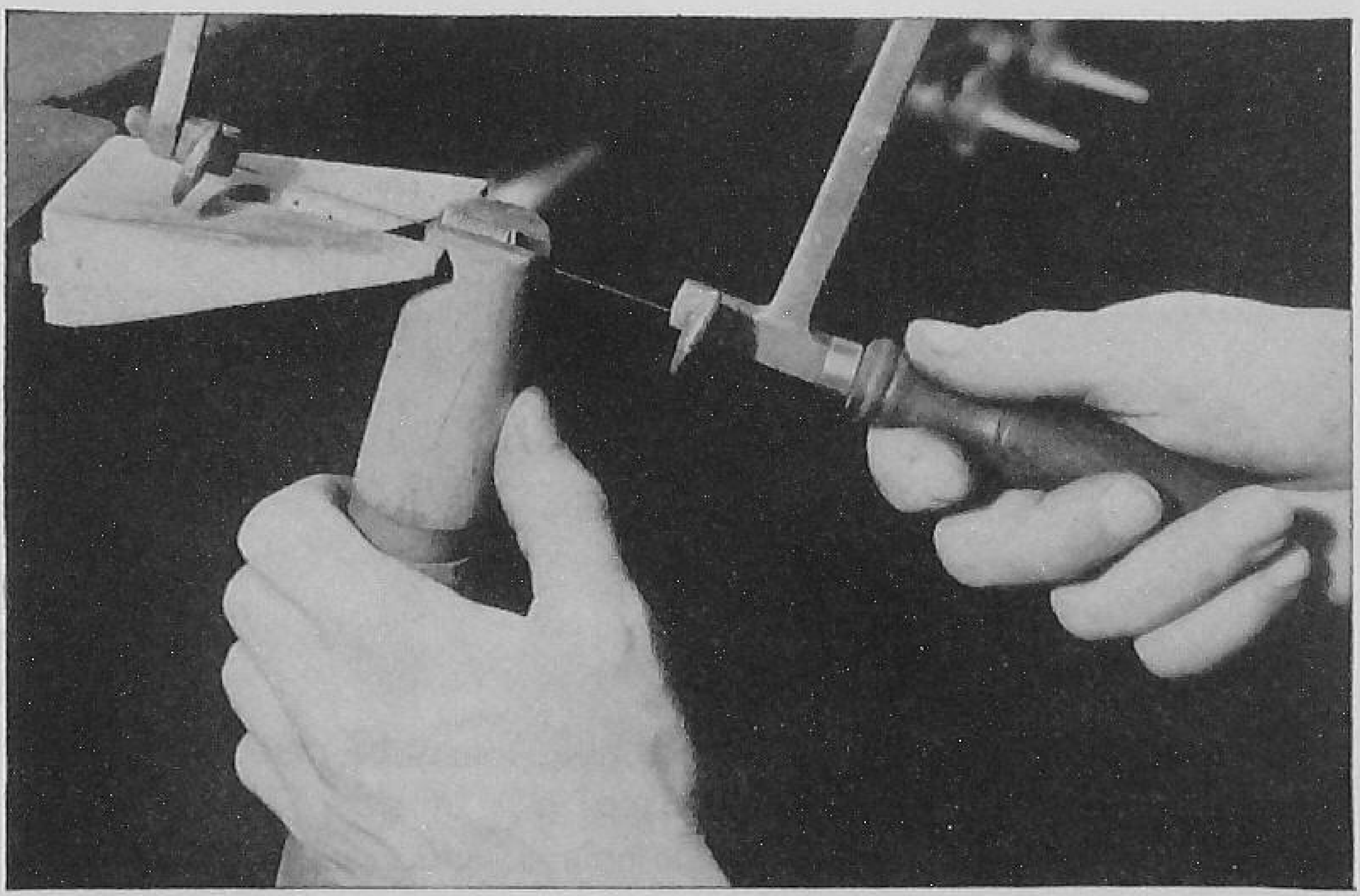


FIG. 74. Sawing open a coil to make individual links. A ring clamp may be used.

When the coil is removed from the mandrel, saw through one side of the coil, using a device as shown in Fig. 74. A ring clamp may be substituted, as in the figure. In sawing, thread the blade through the coil and saw from the inside out. This will yield a quantity of single rings, slit at one point. To open the links, use the method shown in Fig. 20, p. 446.

If method *B* is used, it will be difficult to close the ring. A group of

links may be closed and soldered. Wire-form solder may be used. Heat the link to red heat, after flux has been applied, and touch the joint of the link with the wire when the link glows. The group of closed links may then be consolidated by joining two closed links with a third open link. Solder this link. Such groups of three may be joined with additional open links, etc.

Several forms of chains are shown in Fig. 79.

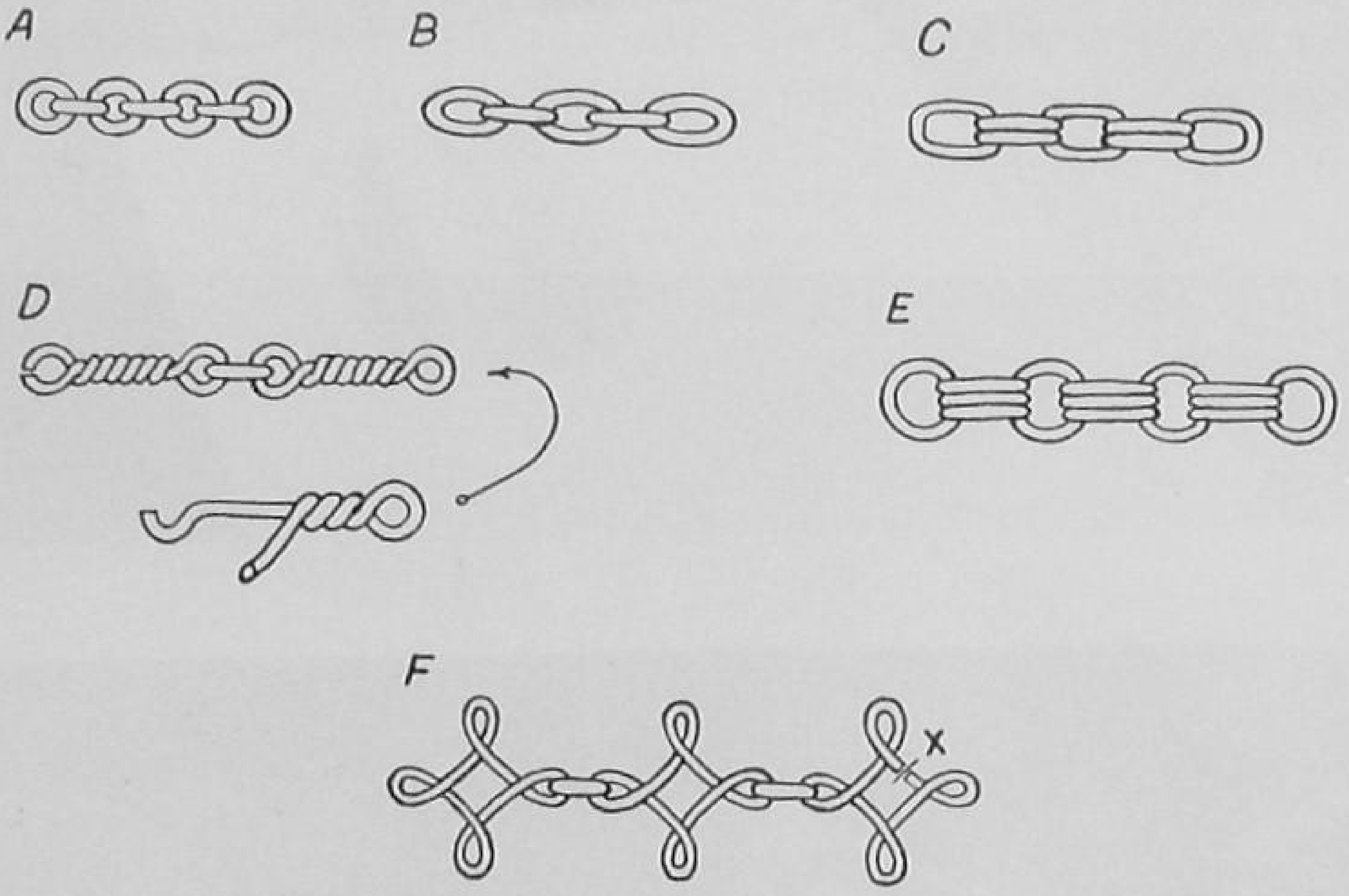


FIG. 75.

The connecting links shown at *E* (Fig. 75) may be made of round or half-round wire. Three lengths are placed side by side. The wire pieces must be absolutely straight or considerable difficulty will be encountered during soldering. To make straight lengths of wire, clamp one end of a length in a vise, grip the other end with a draw tongs, or heavy pliers, and pull hard. The straight lengths are placed side by side on an asbestos block and a brush dipped in flux is drawn along the length of the wires. The flux will be drawn into the crevices formed by the junction of the wires. Place tiny pieces of solder at ½″ intervals and heat the entire assembly. The wire may be held in place by using a staple, having the shape of a U with a flattened base at each end. Such a staple form may also be made of stiff binding wire (see Fig. 76).

The resulting stock, composed of the three-wire lengths, may be cut to

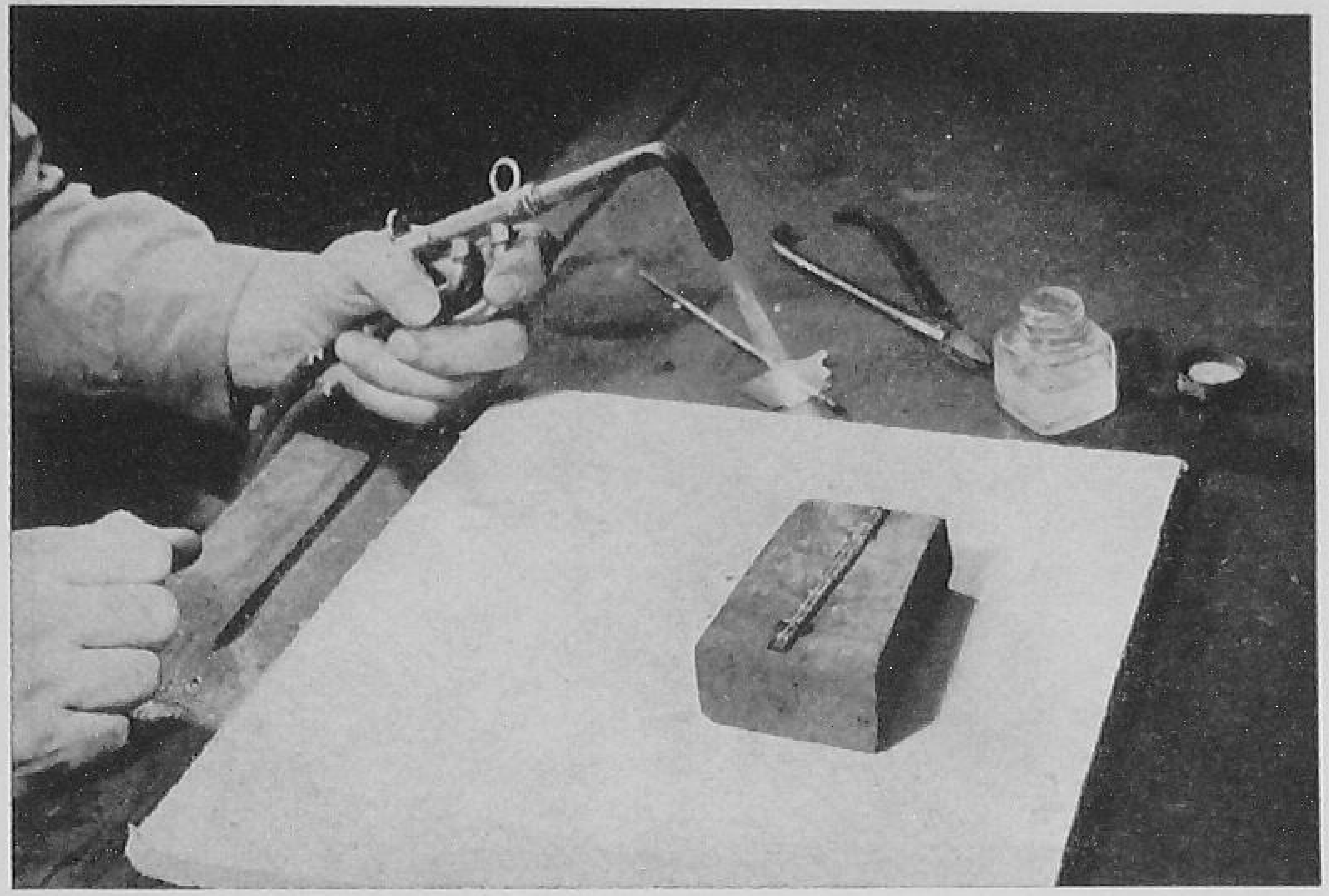


Fig. 76A and B. Hard-soldering parallel sections of wire. Two stages of the technique. In "B" solder has melted over wires.

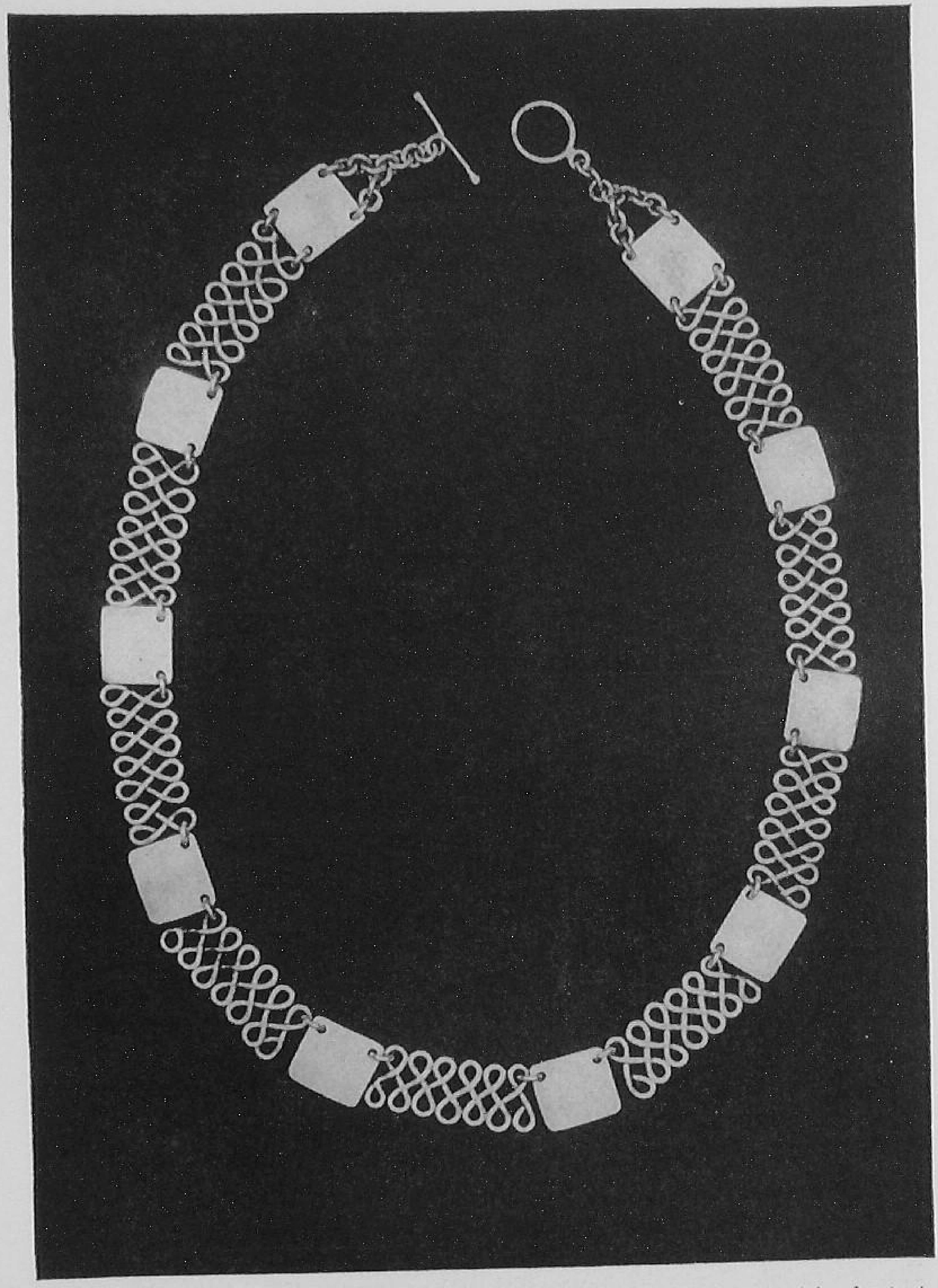


FIG. 77. A necklace. Such links may be made by a nail-jig as described in the text.

proper lengths, and links formed. Do not attempt to make such lengths greater than 5″ or 6″. Longer lengths of wire are difficult to place in parallel groups.

The wire links shown in the necklace, Fig. 77, may be made by driving nails, spaced properly in parallel lines, into a block of wood. The heads should be removed from the nails to facilitate the removal of a link. Bend the wire around the shank of each nail to form the links, which are later closed by hard-soldering. The links are soldered at the ends, and at points where wires cross over. The completed units are connected with ordinary circular links.

Wire Projects

Rings.

Endless projects will suggest themselves once the craftsman has attempted a few projects formed principally of wire. Fig. 78 shows two popular rings formed entirely of wire. A piece of wire, No. 16 or 14 gauge and about 4″ long, is knotted in the center. One end of the knotted wire is grasped with a heavy pliers or draw tongs. The other end is held in a

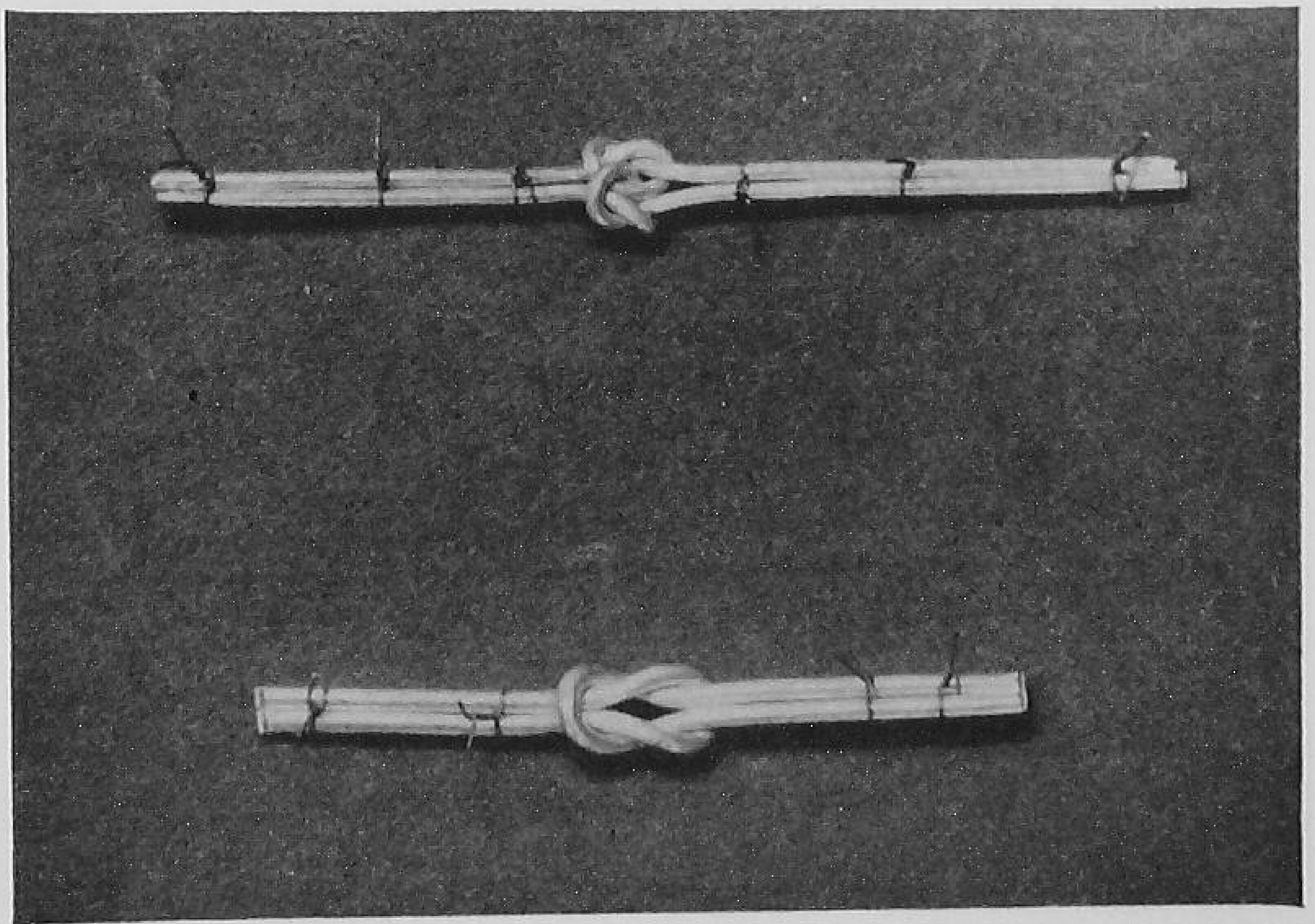


Fig. 78. Two "knot" rings tied with binding wire in preparation for hard-soldering.

vise. Pull the wire to partially close the knot. The second wire is inserted through the partially closed knot and then knotted to form the double-knot ring. Both wires should be pulled in turn to make the knots identical in size. The shank portion of the ring is soldered after being squeezed parallel. The ring is then bent on a mandrel to the proper size. The knot is flattened somewhat by hitting lightly with a fiber or rawhide mallet. Saw the ends square and solder. Clean up the joint with a fine needle file if necessary, true up the ring on a mandrel, and polish.

Open-End Bracelet.

A heavy bracelet consisting principally of twisted wire may be made by referring to Fig. 79. The twisted and square wires are soldered to a base consisting of a piece of flat silver, No. 18 gauge, about 6½″ in length, including the shaped ends. The wires applied are the following:

1. A length of wire or strip, half-round in cross section, and at least ⅛″ wide;
2. A length of No. 18 round wire, doubled and tightly twisted (this length may be slightly flattened by hammering);
3. A length of square No. 16 wire;
4. Similar to No. 2 but twisted in opposite direction;

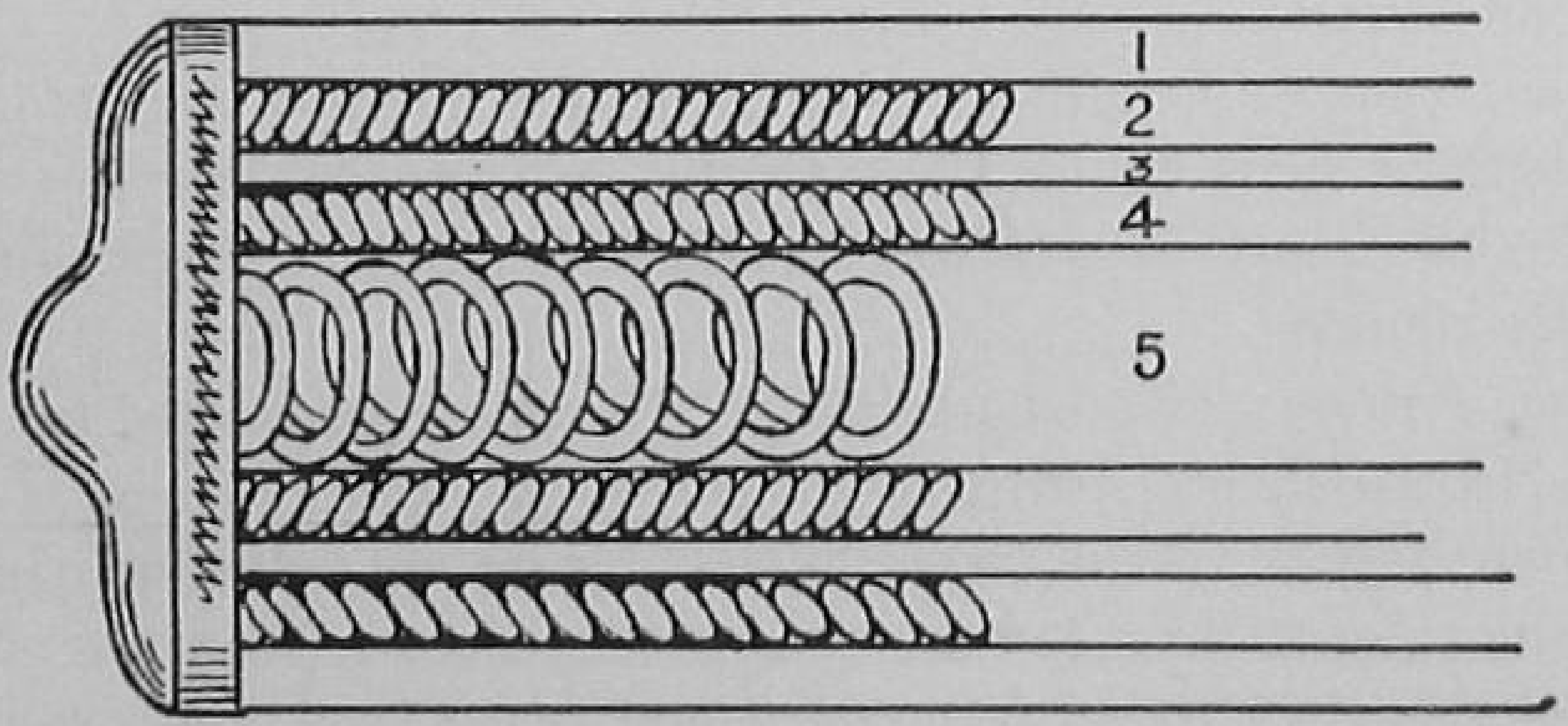


FIG. 79.

5. May be any large unit, elaborate or otherwise. (Fig. 79 shows a coil of No. 18 round wire, hammered with rawhide mallet so as to lie fairly flat.)

Following this is a repetition of group 1-2-3-4. A strip of flat silver, No. 20, covers the ends of the wires, overlapping slightly, to the underside.

This piece may be chased or left plain. The whole may be shaped on a bracelet mandrel after all hard-soldering has been completed.

An alternative to the coiled center unit may be made by utilizing two strands of twisted No. 18 wire. These two strands are retwisted into one high, decorative, central unit.

Bangle Bracelet.

A beautiful bangle bracelet may be made by twisting strands of No. 16 wire to form a herringbone pattern. Two lengths are twisted, remembering to twist each the same number of turns, and *reversing* the direction of the twist on the second strand. The two twists are soldered together, side by side, with ⅛″ diameter shot mounted as shown in Fig. 80. Square U-staples will aid in keeping the twists flat. When joining the two ends of the formed bracelet, coat the bracelet liberally with yellow ochre leaving only the ends clean.

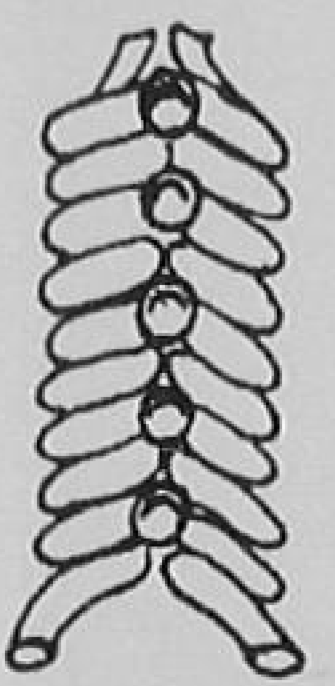


FIG. 80.

Clip-on Type Bracelets.

Fig. 81 shows a group of very decorative clip-on type bracelets made by Frank Frost. An analysis of the procedures used follows:

Left row; top: Three lengths of No. 10 silver wire soldered parallel. Ends cut off square.

Left row; center: Length of No. 14 round doubled and twisted. A second length of same doubled and twisted in *opposite* direction. Middle wire is No. 10 square. Three lengths soldered parallel. Ends cut square and slightly rounded.

Left row; bottom: Two lengths of No. 10 square, separated by a single length of No. 10 square, twisted with carpenter's brace.

Right row; top: Two lengths of No. 10 square are rolled or hammered, reducing thickness slightly, but resulting in a broader top surface. A length of No. 14 or No. 12 round is doubled and twisted by spool method, or brace, then rolled or hammered flat and to same thickness as "square" wires. The ends of this bracelet were treated by a method favored by some Mexican craftsmen: A powerful flame is concentrated on an end until it melts and the wire ends flow together. (The rest of the bracelet might be protected by laying a magnesium soldering block over it.) The solid end is then filed to a desirable, slightly tapering shape, and a pair of cross-lines filed where the solid merges with the wire shape.

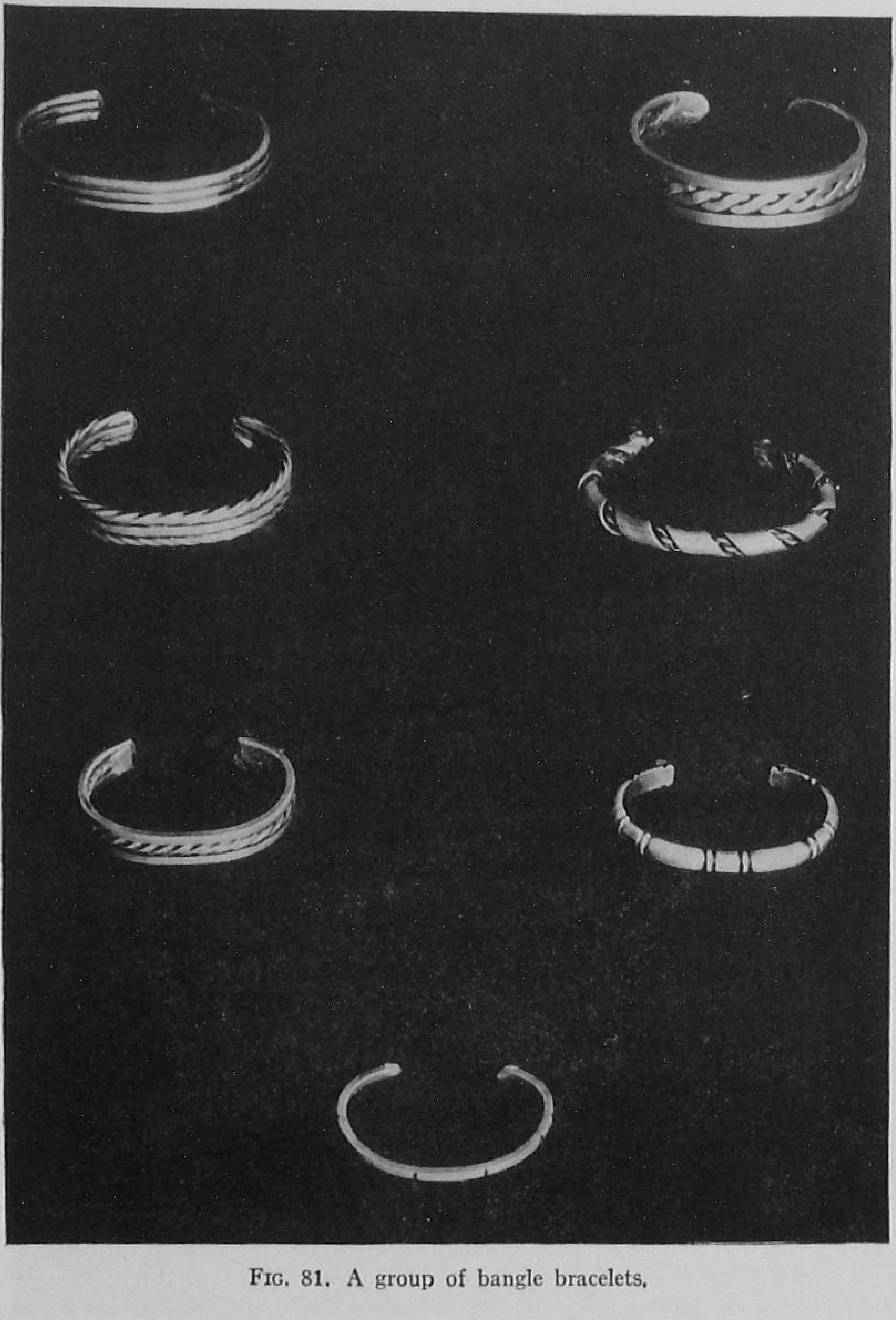


FIG. 81. A group of bangle bracelets.

Right row; center: A "ribbon" of No. 18 sheet, 3/8" wide, is coiled around a piece of No. 8 copper or silver round wire. A length of No. 18 round is doubled and twisted. The resulting "twist" is then wound into the ribbon spaces. The ends may be soldered or melted as previously described.

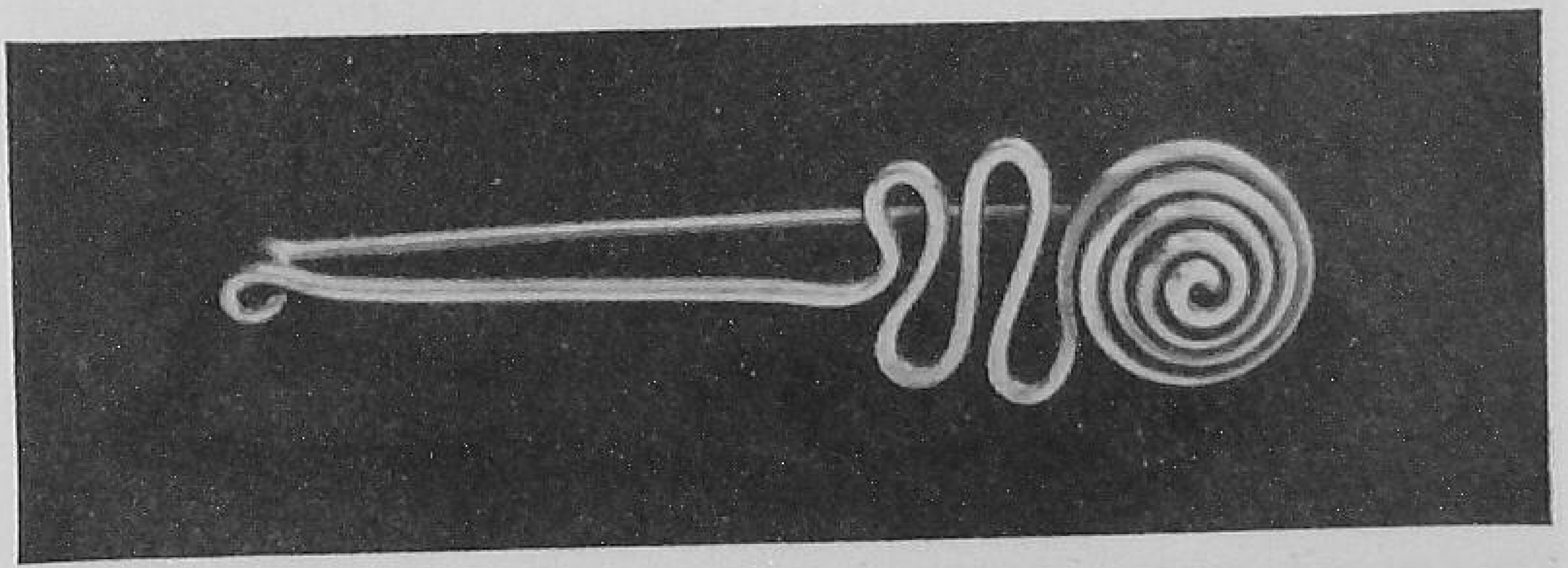
Right row; bottom: This bracelet was filed from a solid silver bar 5/16" wide and 3/16" thick. The sections are laid out and wire-like separators filed first. Next the long ovals are filed, then the half-sectioned octagonal form.

The last bracelet on the bottom of the plate is simply a piece of No. 10 square wire with a few filed notches.

All bracelets are formed with a raw-hide or fiber mallet on a bracelet mandrel, after wire working and end-soldering have been completed. Polishing and antiquing complete the bracelet.

Forming Whorls of Wire.

Whorls, or flat coils of wire, are useful as decorations to be applied, or they may form in themselves pieces of jewelry such as earrings, cuff links, or bracelets (Fig. 82, *A* and *B*). These whorls may be formed by various



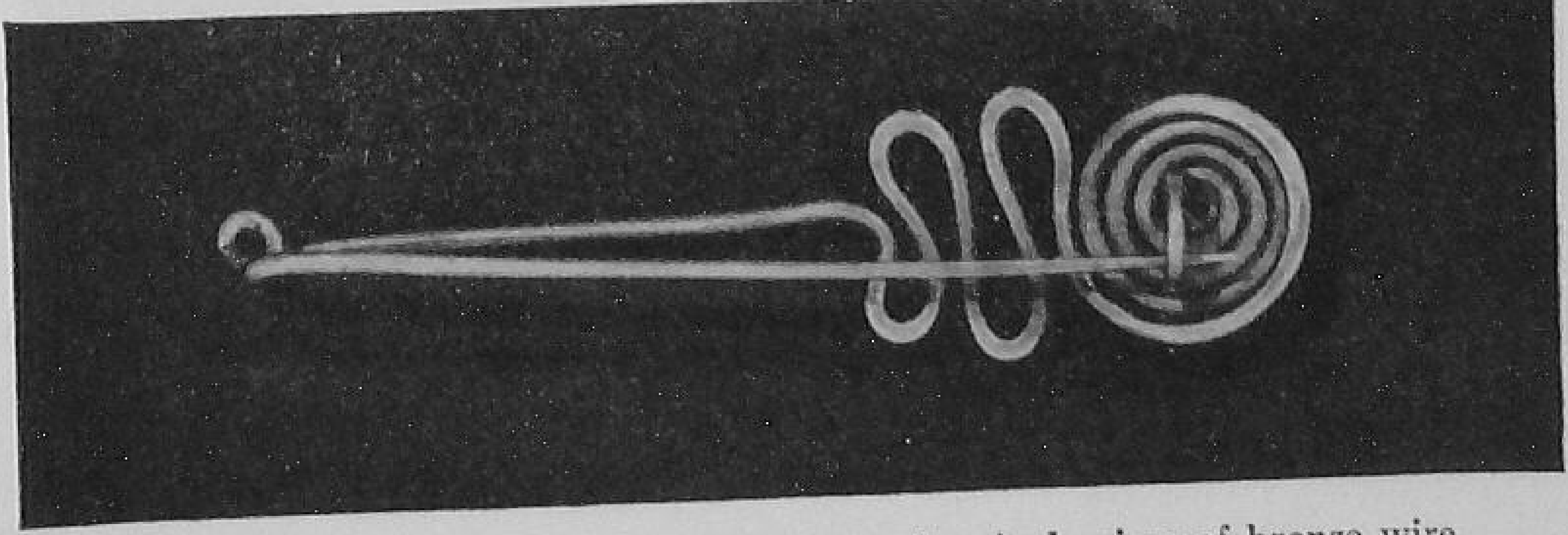


Fig. 82A and B. An interesting pin made of a single piece of bronze wire.

methods but the simplest and most satisfactory involves the use of a small hand vise. First, prepare a surface upon which the wire coil may rest during winding. This may be done easily by securing a small foreign coin, preferably of nickel, because of its hardness. Rub one surface on a piece of No. ½ emery cloth, placed face-up on a surface plate. This will yield a disc with one smooth working face. Drill a hole through the center of this coin, large enough to permit the entry of the size wire to be used for coils. Now, with the jeweler's saw, cut a path to the center hole, reverse, and cut out to the edge of the coin again, leaving a slot wide enough to permit removing the coin from the wire if double coils are to be wound, such as are needed for the whorl bracelet.

To form whorls, use *annealed* wire. Most wire is purchased in this form. Pass one end of the wire through the center of the disc and double that end over for a distance of approximately ¼″. This prevents the wire from slipping in the vise jaws. Now tighten this end in the center of the vise jaws and slide the disc against the top of the jaws, smooth side up. Carefully start the center of the whorl. It is at this point that the greatest tendency for the wire to break exists. Hold the hand vise as shown in Fig. 83 and wind the coils, rotating the vise in the hands as the work proceeds. To avoid breakage, wind the wire about the coil as the vise is

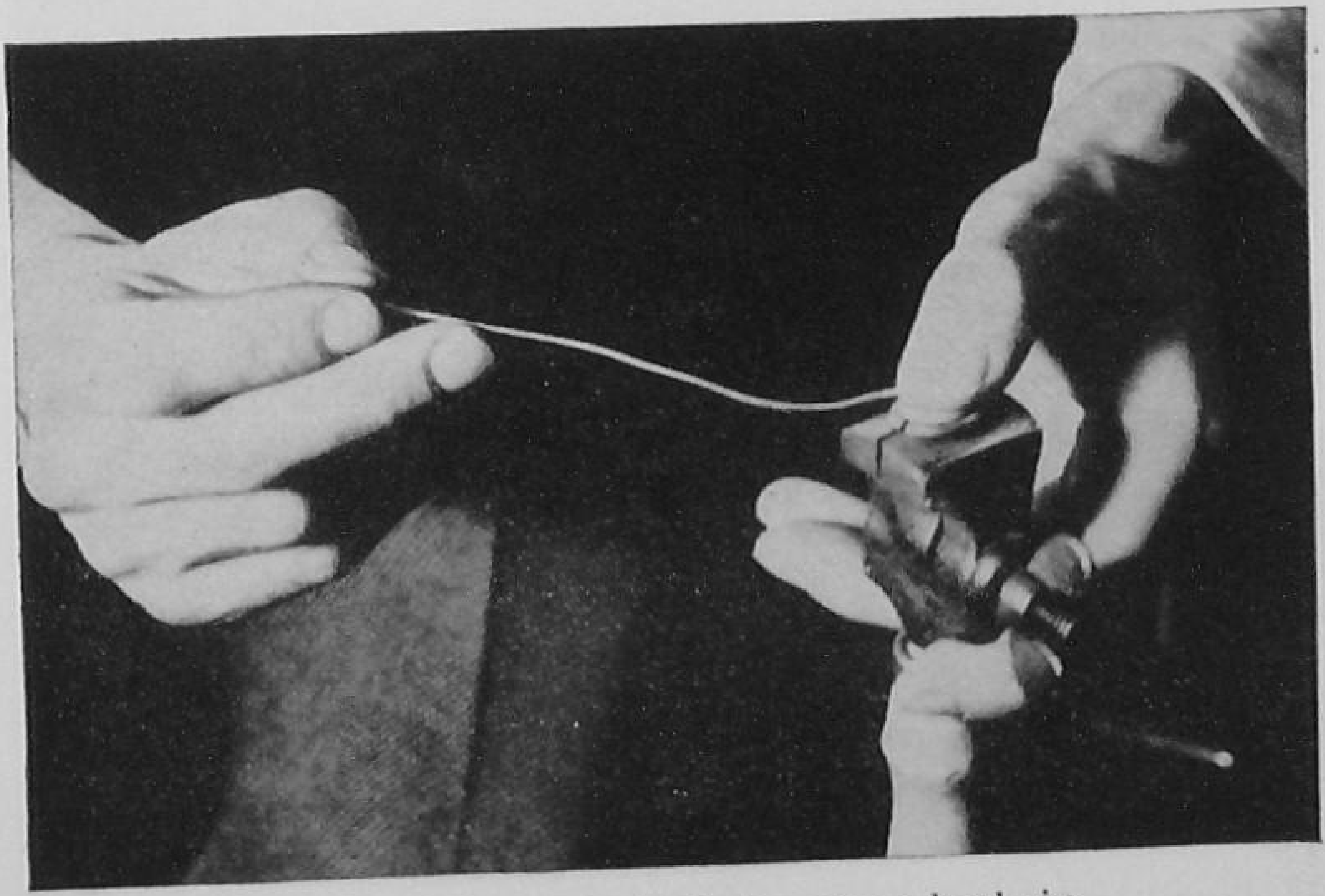


FIG. 83. Forming whorls of wire using a hand vise.

turned rather than relying on the rotation of the vise alone to form the coils. After the required number of turns, the coil may be slightly flattened and stiffened by tapping its surface lightly with a smooth, polished hammer, against the nickel disc. The whorl may be removed from the vise, and the under-end cut off. These whorls may be slightly cupped by workink them into the hollow of a dapping die or by shaping in a lead block. Shot may be applied at the center of the whorl, if desired, for further decoration.

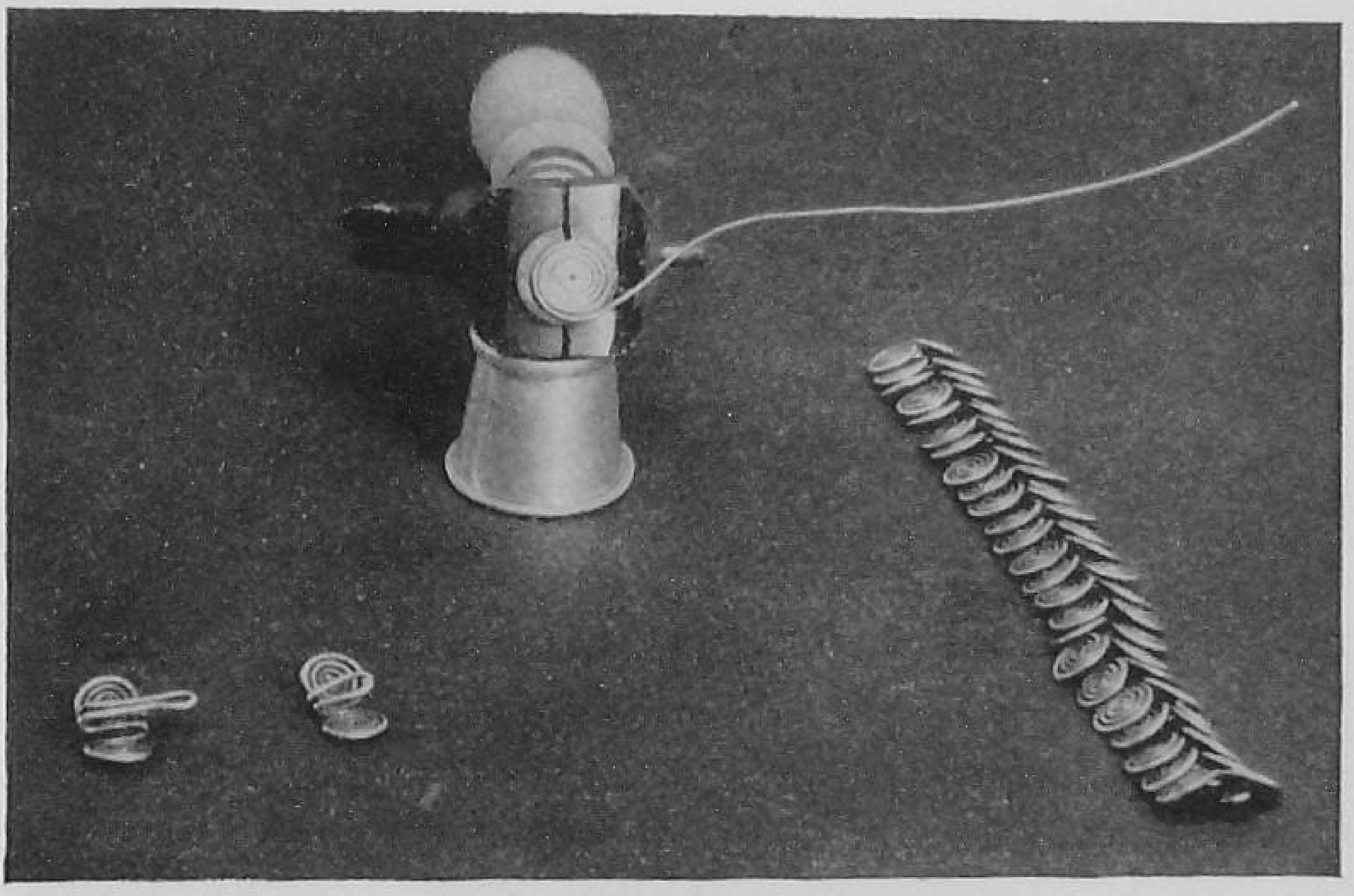


FIG. 84. A whorl, the end-links, and the bracelet.

The whorl bracelet, illustrated in Fig. 84, consists of links made as follows: A length of wire No. 18 or 20 approximately 8″ in length is cut. A coil is wound on each end, consisting of about 4 or 5 turns. The slot in the disc used with the vise makes the removal of the disc possible. The coiled wire is then bent as shown in Fig. 85*A*.

The distance across the coils is about 1″. The total height of the loop is the same. Next, bend the loop over in back of the coils (Fig. 85*B*). Enough of these links are made to provide a necklace or bracelet. The loop on each set of coils is inserted through the previous loop. When a chain of such links is complete, put a link through the top of the first set

of coils. The last set of coils is wound from wire 1½" longer than the previous lengths used. This provides enough material for the double-bent, final set of coils, as shown in the figure. A jump-ring links the two ends of the chain (Fig. 85*C*). The coils of this chain are bent at a slight angle to each other, forming the sloping sides visible in the photograph of the finished chain.

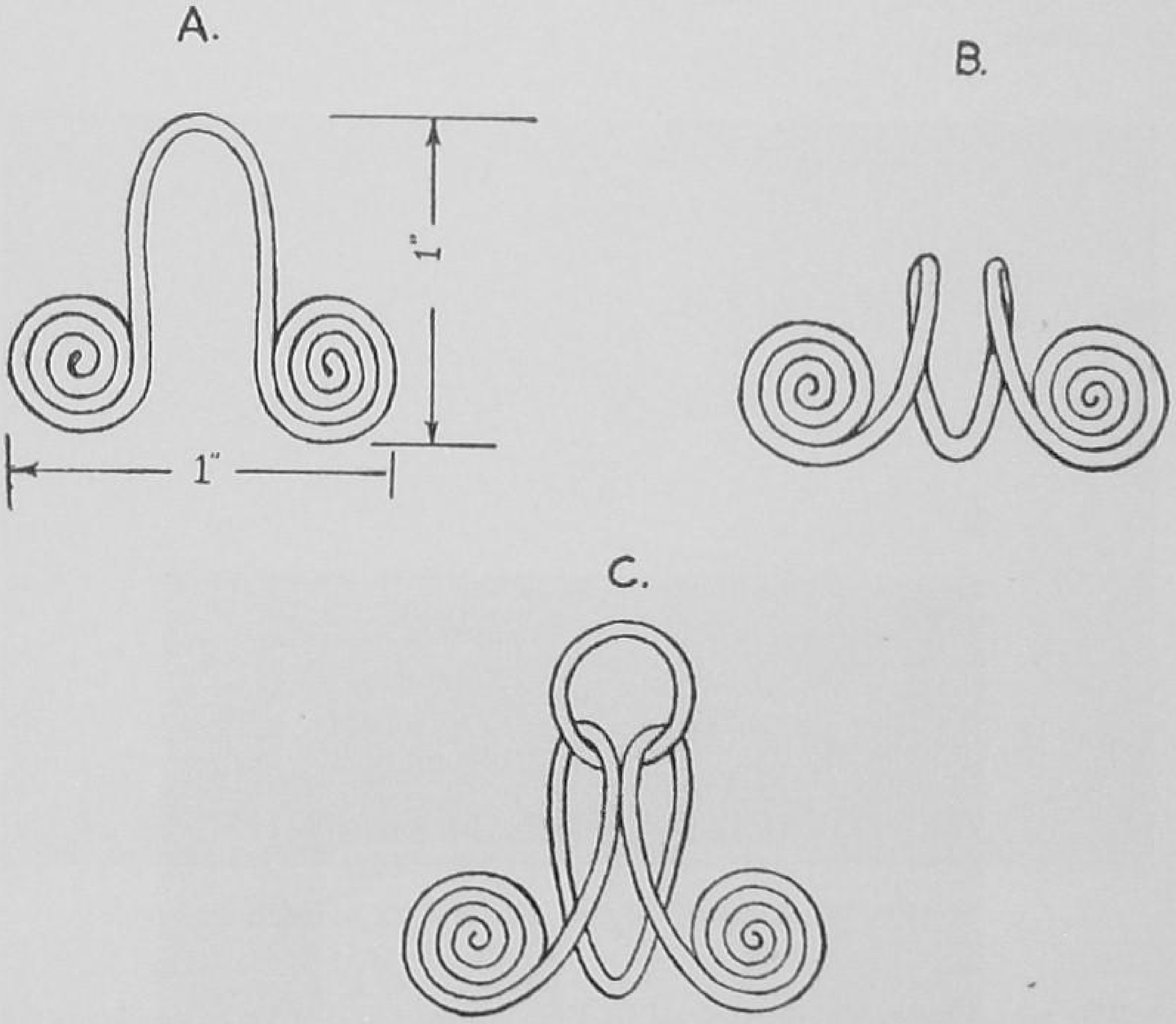


Fig. 85.

Additional decorative effect may be secured by soldering a shot in the center of each coil. Antique the coils, rub with whiting for highlights, and give shot a high polish.

Fig. 86 shows an Etruscan design for a link, originally of bronze wire. This is a combination of the "whorl" technique and the bending technique described elsewhere in this chapter, with reference to the making of links such as shown in the necklace (Fig. 77). Six nails are used for this whorl-

type link. Here again, the whorl may be used as is or may be decorated with shot at the center of each whorl.

Fig. 87 shows wire used decoratively in the form of appliqué.

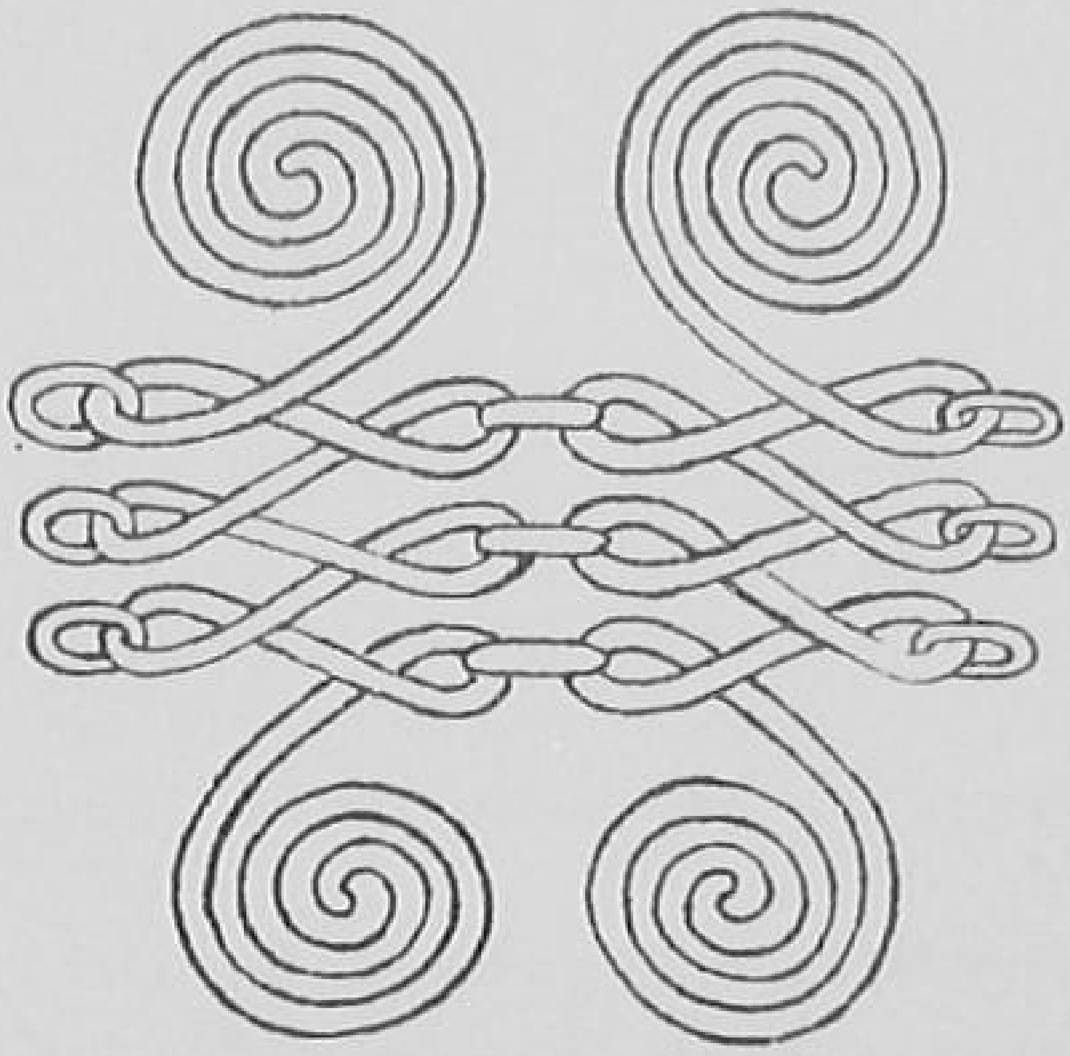


Fig. 86.

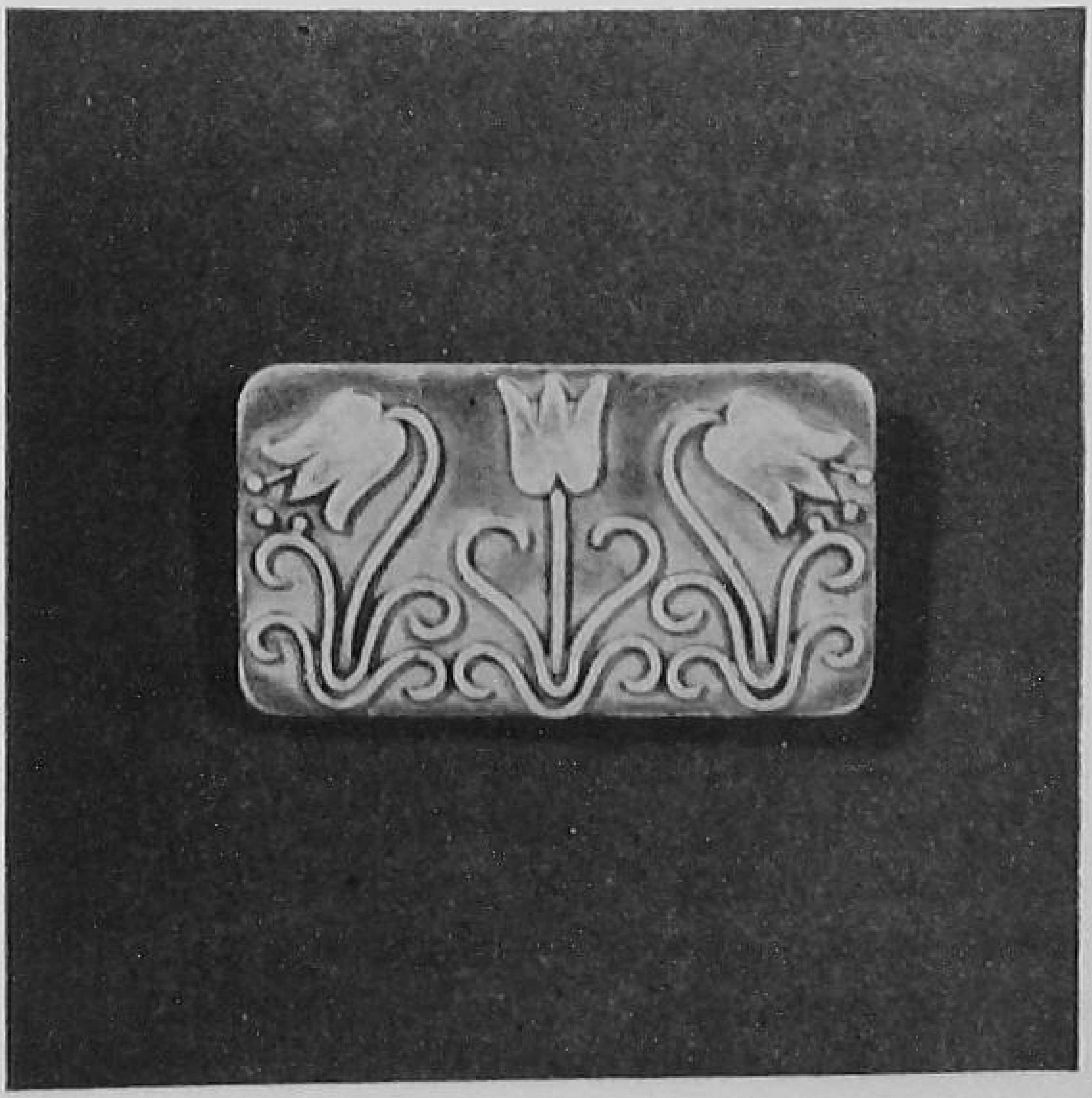


Fig. 87. Wire appliqué work. (*Courtesy Anna Halasi.*)

Chapter XV

MISCELLANEOUS CONSTRUCTIONS

Although silver, gold, and base metal findings are available from many sources—principally manufacturers in Providence, R. I.—there are occasions when the craftsman wishes to construct his own bracelet or necklace catches. Joints, catches and ear wires do not usually play any conspicuous part in the design of a piece of jewelry, but the clasp or catch may very well be integrated as part of the over-all design of a necklace or bracelet.

The basic mechanism of a clasp, when understood, can be incorporated into a link, either plain or highly decorated with some form of overlay.

Essentially, a common clasp is a small box or socket, which receives the tongue or catch and holds it fast. In the accompanying figure (Fig. 88), the essentials of such a clasp are shown. The box may fit underneath a link or a link may be so designed as to leave room for such a box. No. 24 gauge metal will suffice for its construction. The tongue may be bent over a knife edge and hammered hard to give spring to it.

Construction details show the evolution of the box catch from the flat layout at 1 to the completed link at 4 (Fig. 88). Note the two possible forms for the spring. *A* is a bent-over piece of metal. Though this is quite common, there is a possibility of breakage at this bend after much use. At *B* is another form in which the spring is cut free from the previously hardened piece of metal. This is pierced free with a jeweler's saw. It is bent upward to allow sufficient spring. The upright projection which takes the knob is soldered on. If necessary, rehammer to harden. The knob projects somewhat over the top of the box catch, so that it may be depressed to release the spring. Study the principle of this mechanism and it will be found applicable to innumerable forms of links.

Fig. 89 shows another type of clasp, useful for bracelets and watch bands. Parts *A* and *B* are cut from sheet metal. The gauge of metal used will depend on the weight of the metal used for the remaining links. Two pieces of No. 20 are suggested. They are to be cut and pierced identically

except for the slight difference in the pierced pattern. Part *A* is sweat-soldered over *B* to give *C*, with two little inner ledges at the front.

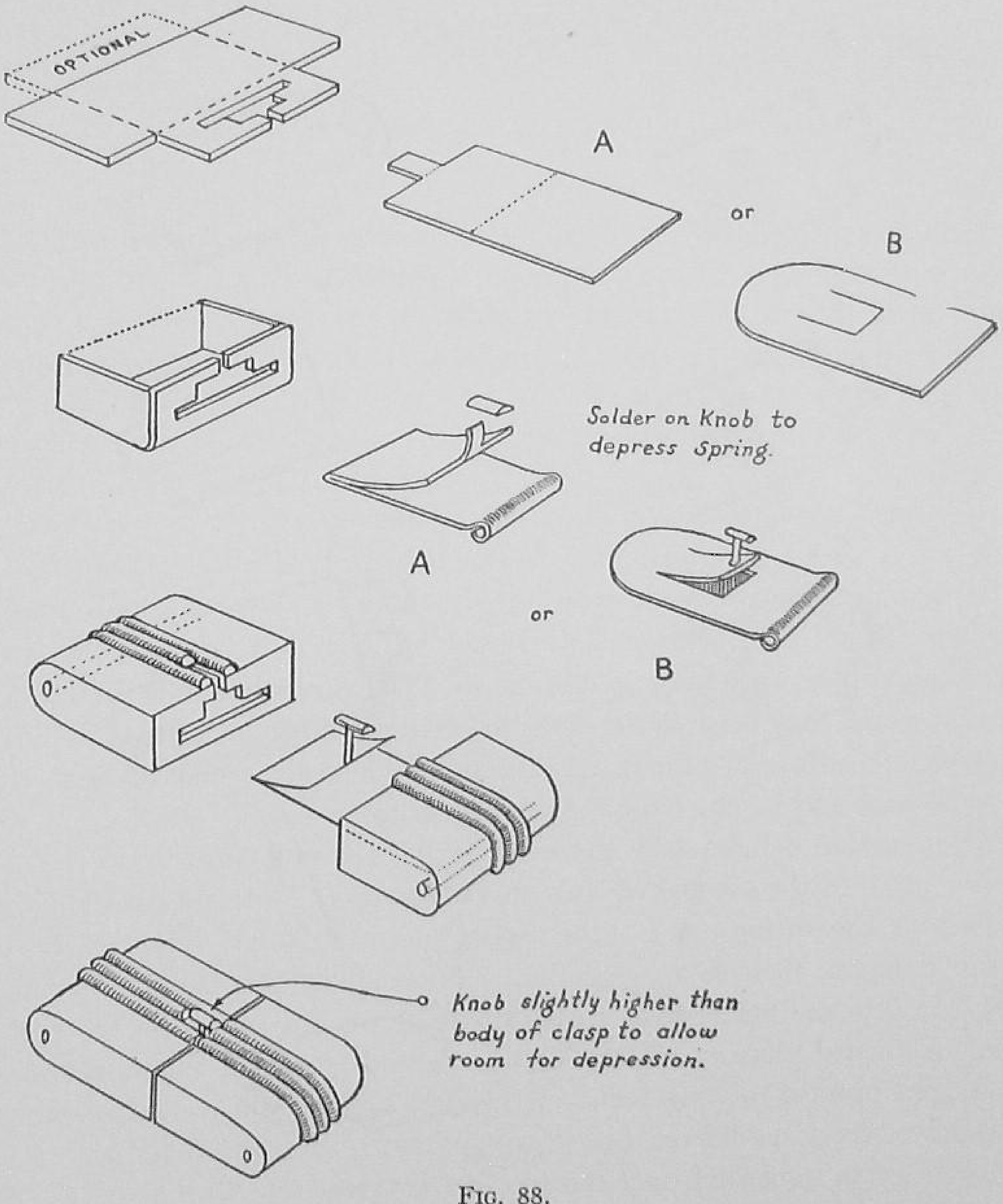


Fig. 88.

Parts *D* and *E* are made of similar material. *E* is sweat-soldered over *D* and a little strip is soldered over the projection on *D*. This strip equals in size one "leg" of the H-shaped section cut in part *C*. The resulting piece is shown at *F*.

The assembled clasp is shown at *G*. Note part *X* occupying its proper

"closed" position after having been inserted up through the rear leg of the cut-out from the under-side. It is then slipped forward to rest on the

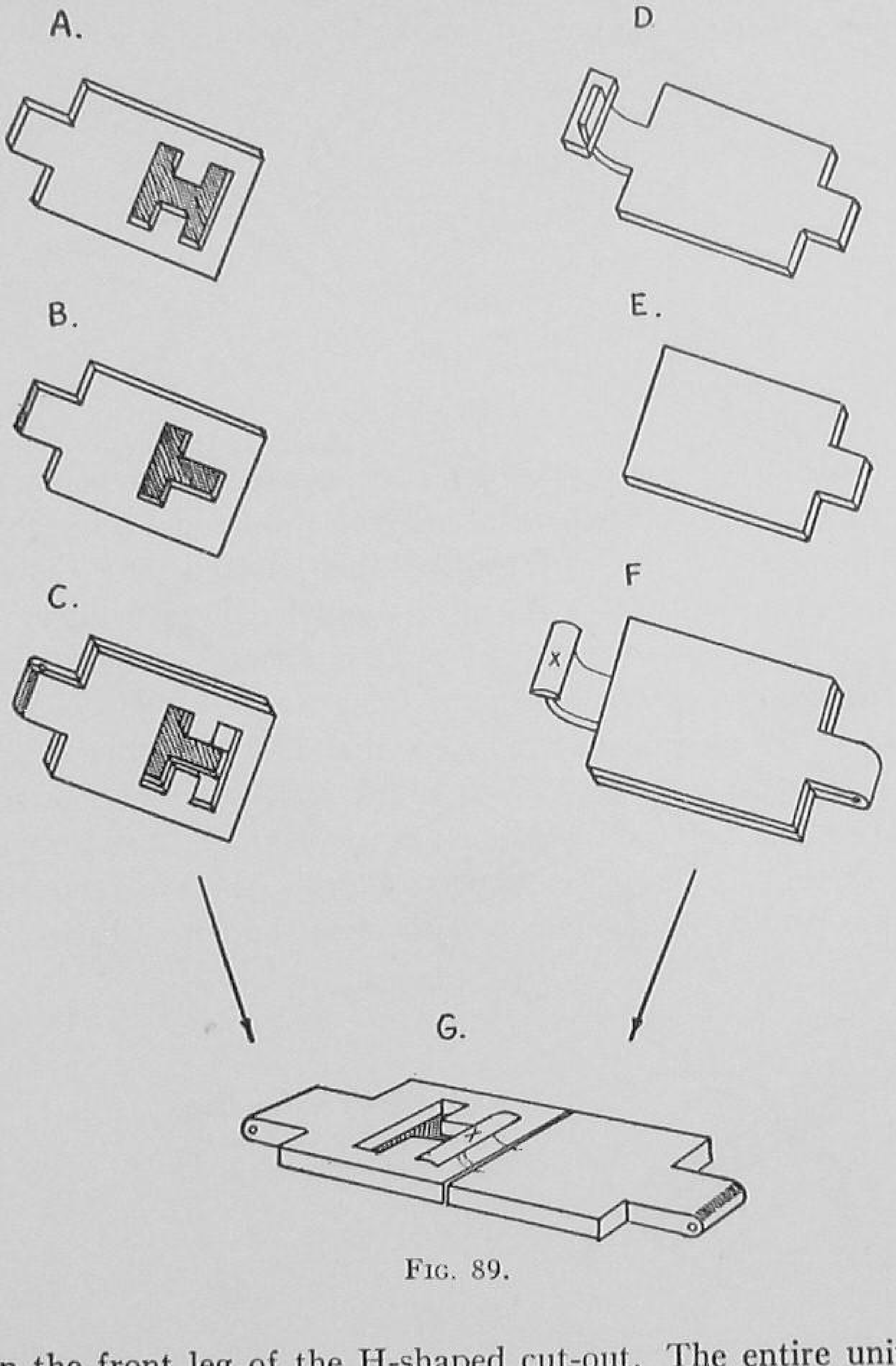


Fig. 89.

ledges on the front leg of the H-shaped cut-out. The entire unit may be slightly curved over a properly shaped mandrel, so as to conform with a wrist curve.

Fig. 90 shows a type of link construction with a simple clasp. Many forms of this link may be used, and applied ornament possibilities are limitless.

Essentially, the links are slightly curved rectangles of metal. On one end of each link is centered a piece of tubing. (See chapter on "Small Tools," for tubing construction.) On the opposite ends of each link are two shorter pieces of tubing of similar diameter. When the links are

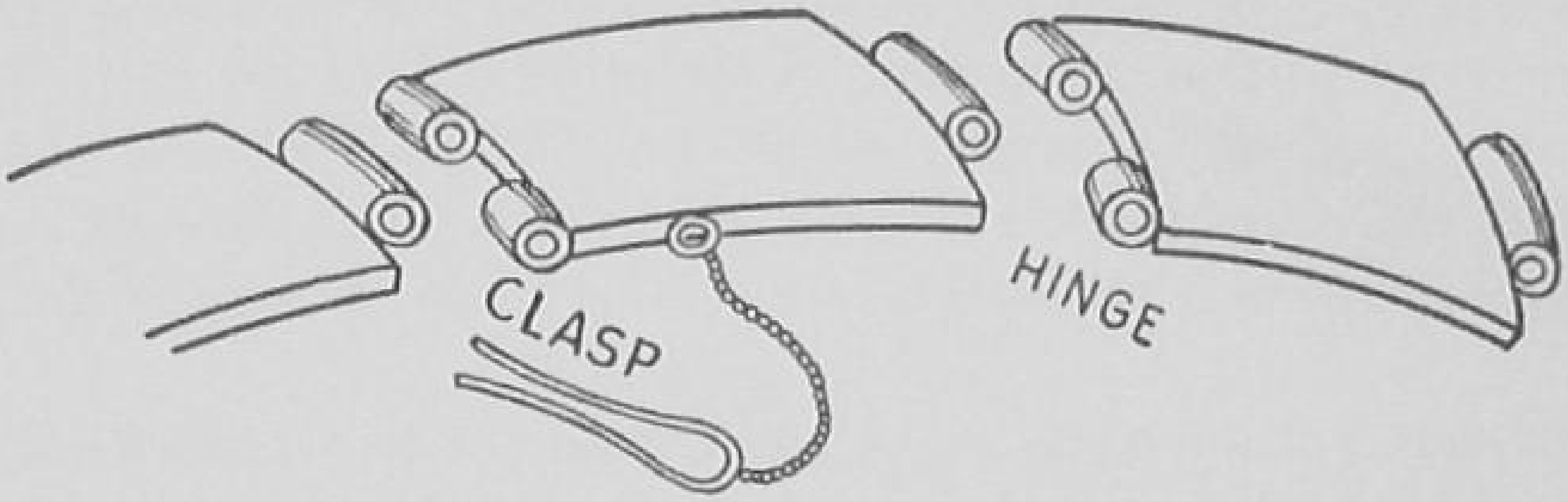


FIG. 90.

properly assembled, they are permanently connected by passing a length of rivet wire or the desired metal wire of proper diameter through the tubing. The ends of the wire pin are then riveted over the tubing by gently hammering with the ball end of a small chasing hammer.

The clasp for such a bracelet of links is formed by substituting a removable pin for one of the fixed pins. This removable pin takes the form of a piece of hardened wire bent somewhat like a hairpin or cotter pin. This pin is permanently secured to a link by a piece of fine commercial chain. The "legs" of the pin are given an outward spring so that after insertion through the hinge of a pair of links, the pin tends to stay in place. This is quite an ancient form of clasp, but, nevertheless, effective.

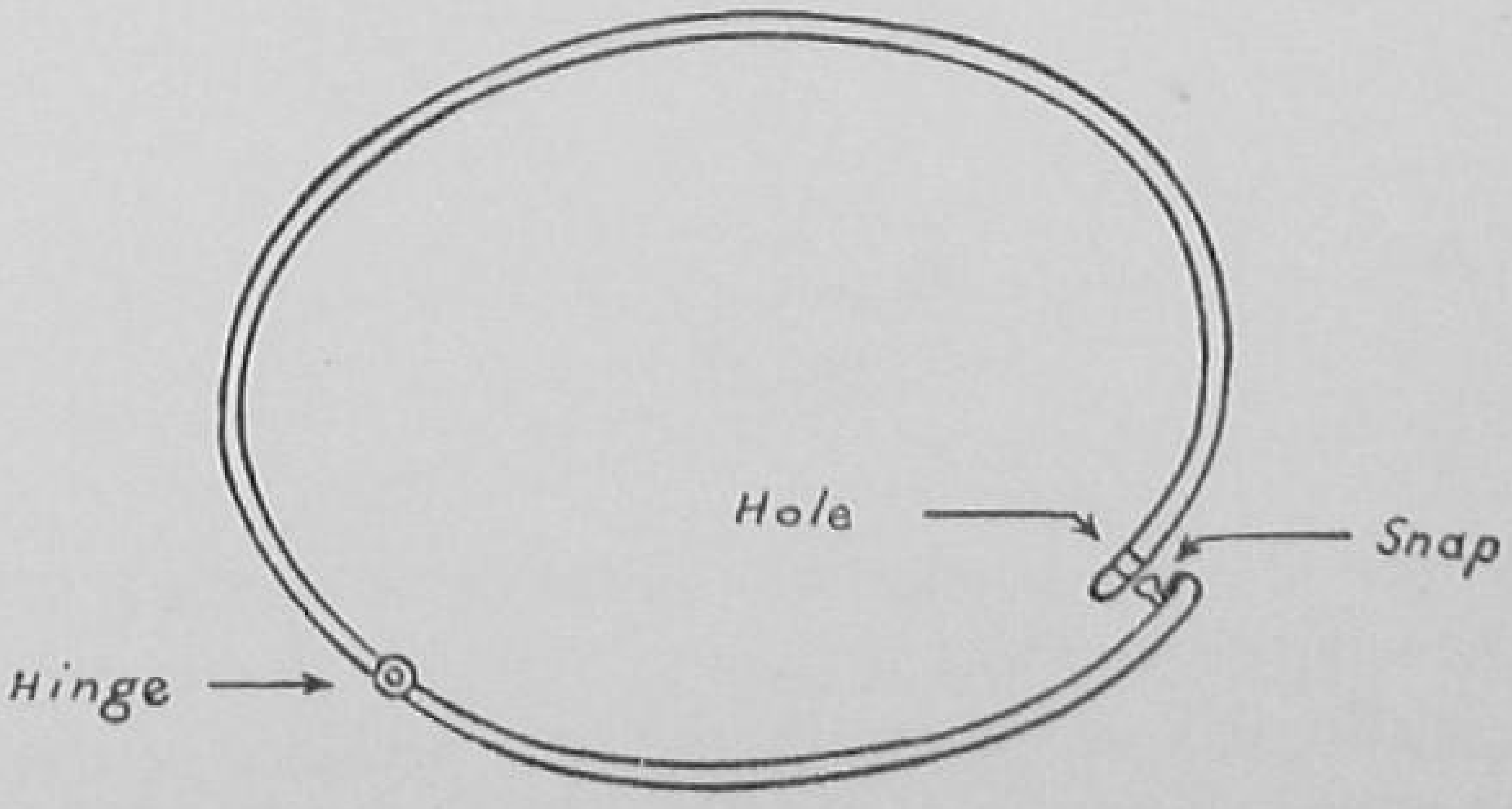
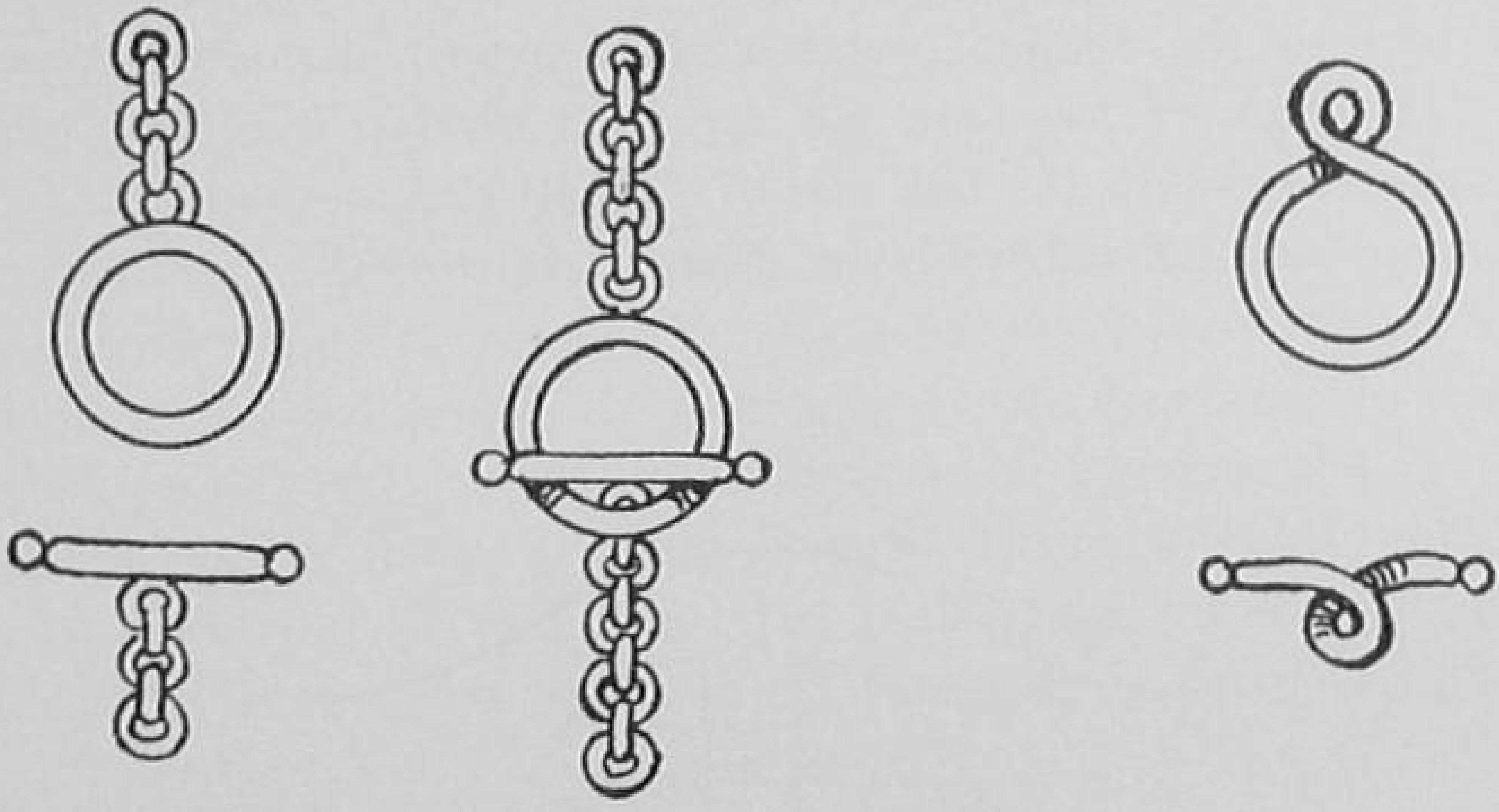


FIG. 91.

A novel use of the spring portion of a leather snap fastener is shown in Fig. 91. The bracelet proper is made in two sections, hinged with a tubing-type hinge.

To the underside of the hinged end of the bracelet is soft-soldered the knob-like spring of an ordinary snap fastener. The point on the opposing piece of bracelet at which the knob-like projection rests is marked with a scriber. Center-punch this spot and drill a hole slightly less in diameter than the knob. A good way to estimate the drill size is to fit a drill into the unused cap portion, or opening, of the other half of the snap fastener. The opening and drill diameter should be similar. Press the snap into the hole to close the bracelet. The metal at which point the hole is drilled should be hammered fairly hard before drilling to avoid wear on the drilled hole.

The thickness of the metal at the hole should not be excessive—the snap should be of enough length to protrude *through* the hole, otherwise it will not act as a fastener.



A B C

Fig. 92.

Simple Clasp.

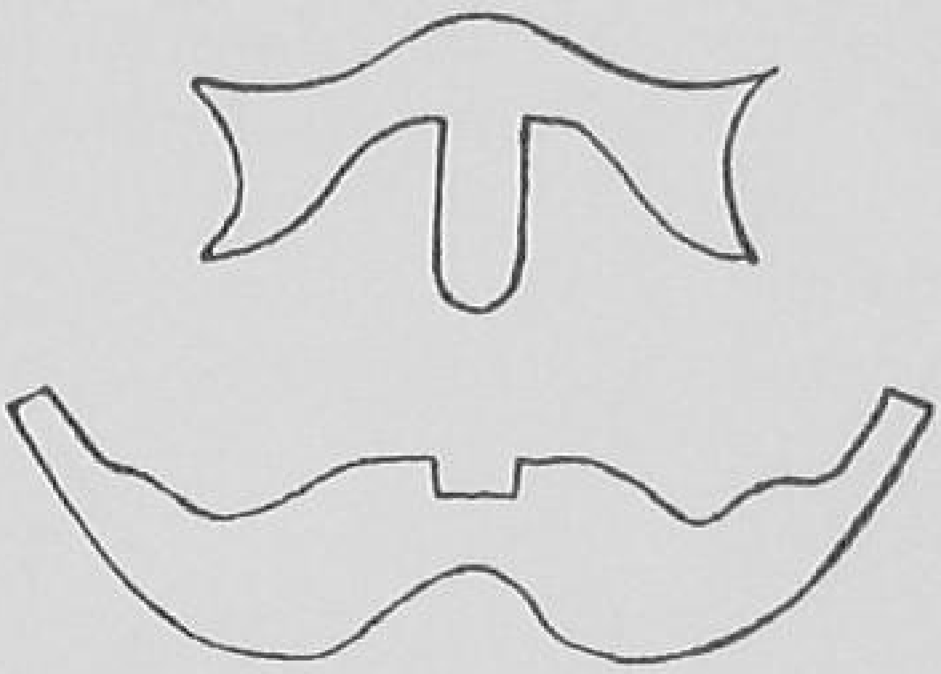
A simple type of clasp, particularly useful for a necklace, is shown in Fig. 92. The large circular link is from ¼″ to 5⁄16″ in diameter. To it is soldered a smaller link, to which the end of a necklace or chain is connected. The large link may be of No. 18 or No. 16 wire. The bar is made of similar wire. Its length, minus the shot, equals the outside diameter of the large link.

To each end is soldered a small shot. At the center is soldered a small link, similar to the one on the large circular link. This connects to the

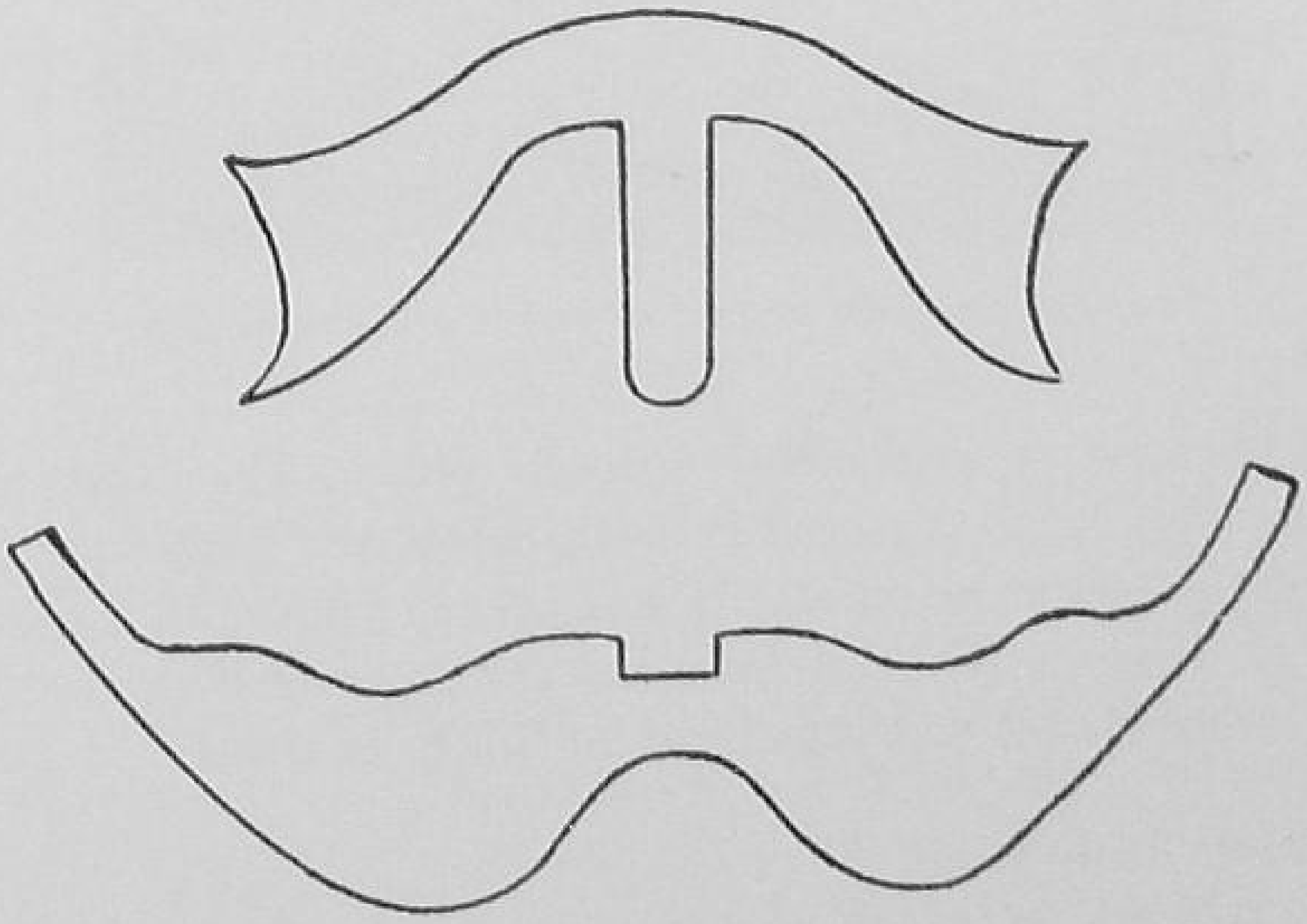
other end of the necklace or chain. Assembled in closed position, they appear as in Fig. 92*B*. At *C*, a constructional variation of such a clasp is shown. These clasps are used in the necklaces, Figs. 40 and 77.

The "Bow."

A construction which is a project in itself is the "bow," which is pictured in Figs. 93 and 94. This may be made of a size suitable for earrings



Pattern for Bow Ear ring



Pattern for Bow Brooch

FIG. 93.

or it may be made larger, for use as a brooch. The parts are cut out with the jeweler's saw, following the outlines given in the figures, and then filed smooth. The metal surfaces should be thoroughly smoothed and polished before any bending is done because the final bent form is difficult to work on with abrasive papers. Shaping is done almost entirely with the fingers. Final assembly is achieved by placing the piece pictured on the

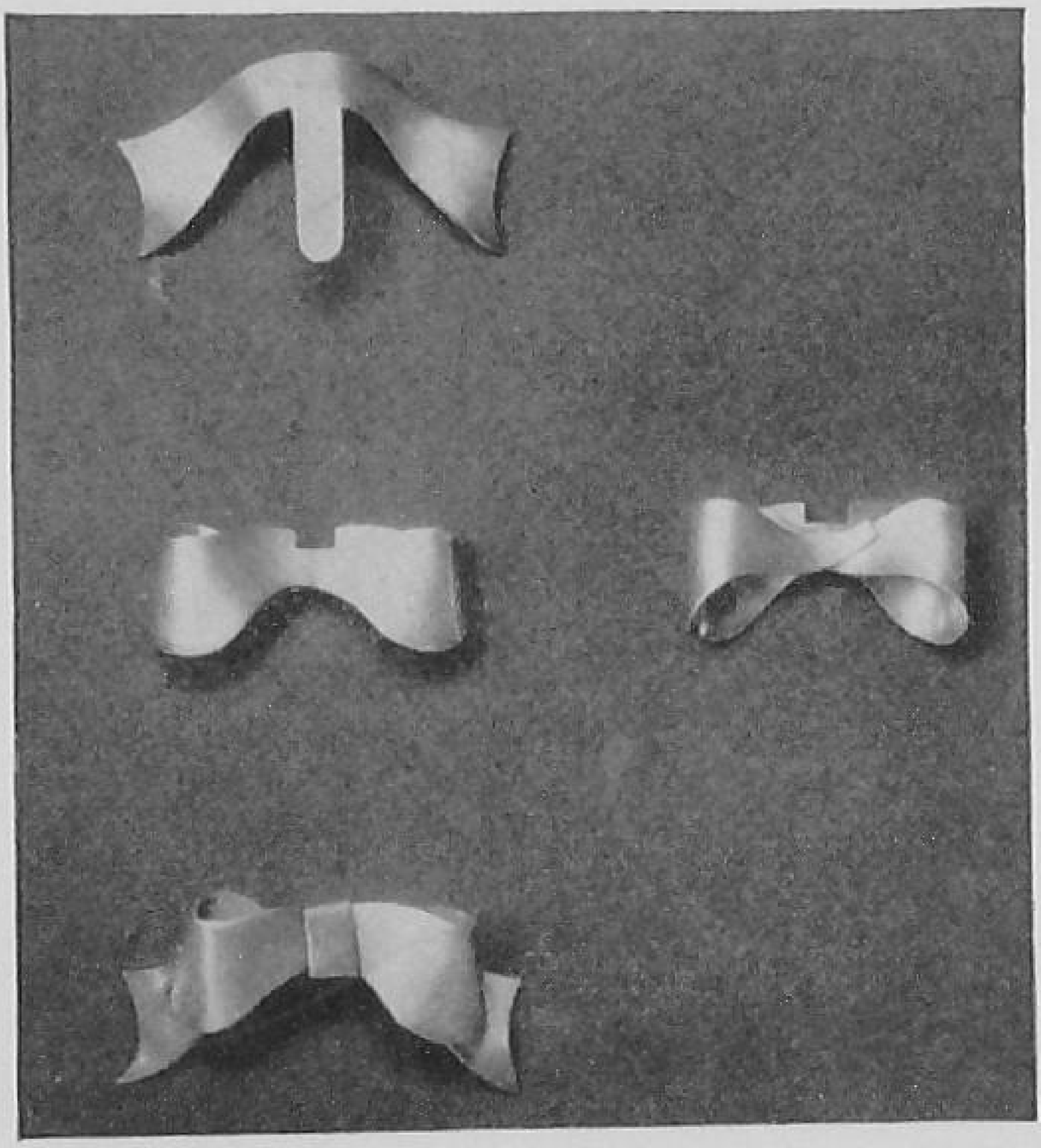


FIG. 94. The bow in several stages of construction.

top of the photograph, under the "looped" piece. The "tongue" is then brought over the complete assembly from below and bent snugly over the top, through the notched portion. It is squeezed tight with a smooth-faced flat pliers. It may be soldered from the reverse side if desired, although if properly assembled it will remain quite firmly in shape.

Tubular Forms From Wire.

In the section describing the use of the draw plate, a method of drawing metal tubing was described. Another means of forming tubing involves the use of wire.

When the inside diameter of the desired tubing is known, wire or rod

of that diameter is employed as a mandrel, or form, around which a coil of wire may be closely wound. When a length of such "coiled" tubing is formed, it may then be made into a rigid tube by soldering the individual turns of the coil together. The easiest way to do this is to employ hard solder filings mixed with a suitable flux.

The mixture of flux and solder filings is brushed over the coil of wire from which the mandrel has been withdrawn. Heat the coil until the solder flows around the turns of the coil. This will occur in an even, thorough fashion if the coil is made of clean wire, closely coiled.

Such lengths of "corrugated" tubing are useful for forming hinges or for use as hinge-like links (Fig. 90). In making such tubing, remember that as the inside diameter of the coil decreases, the diameter of the wire used in making such a coil should also decrease.

APPENDIX

TESTS AND TABLES

Testing Silver and Gold.

Sometimes, a piece of metal scrap or a metal object must be tested to ascertain whether or not it is gold or silver. Some pure nitric acid and a glass stirring rod are all that are needed for these tests.

To test for silver, file a notch, deep enough to penetrate any possible plating, and apply the nitric acid with the glass stirring rod. Sterling silver will show a reaction in the form of a cream-colored cloudy froth. If the metal is coin silver, the reaction will produce a foam tending to blacken. Silver of low grade—750 and lower show different greens, darker as the lower content silver is tested. Comparative checking with silver of known content will aid in identifying these.

To test gold, a notch is filed as described previously. If the acid is applied to gold over 10 karats, (solid) there will be very little reaction, if any at all. Gold of 10 karats will show a slight reaction. If gold has been plated over silver, the reaction will be creamy pink. If plated over a base metal, bright green will result.

TABLE OF MELTING POINTS (°F.)

Aluminum	1218
Antimony	1166
Bismuth	520
Brass, also called "gilding metal" (copper 95 zinc 5)	1949
Brass, casting	2075
Brass, common (copper 65 zinc 35) also called "high brass"	930
Brazing metal (copper 50 zinc 50)	1616
Bronze (copper 80 tin 20)	1868
Copper	1981
Gold	1945
18 K green	1810
18 K red	1655
18 K white	1730
18 K yellow	1700
14 K green	1765
14 K red	1715
14 K white	1825
14 K yellow	1615
10 K green	1580
10 K red	1760
10 K White	1975
10 K yellow	1665
Iridium	4260
Iron	2795
Lead	621
Nickel	2645
Palladium	2831
Platinum	3200
Silver (fine)	1761
Silver (Sterling)	1640
Silver (Coin)	1615
Tin	450
Zinc	787

THE PROCUREMENT OF SUPPLIES

Most craftsmen use the various types of supplies they need in very small quantities. It is, therefore, convenient to purchase all equipment from "general-type" craft supply houses, expressly operated for the amateur craftsman, or small-scale producer of individual items. While the cost per item is generally somewhat higher in such circumstances, ordering, especially from non-urban communities, becomes a simple matter. Most supply houses issue general catalogs, and sometimes bulletins on specific crafts. Make a point of securing such literature not only for ease in ordering and price comparison but for actual educational values. A well made up catalog can teach a great deal about equipment.

The list of supply sources appended are mainly general supply houses. Those marked with an asterisk are supply houses doing considerable business with professional and commercial enterprises. The craftsman will do well to acquaint himself with the complete line and price policy of a few sources before ordering supplies of any nature.

*Anchor Handicrafts Co.	12 John St., N. Y. C., New York
American Handicrafts Co.	45-49 So. Harrison St., East Orange, N. J.
*Brodhead-Garrett Co.	4560 E. 71 St., Cleveland 5, Ohio
*Wm. Dixon, Inc.	32 East Kinney St., Newark, N. J.
Craftsman Supply House	Scottsville, New York
Craft Service	337 University Ave., Rochester 7, N. Y.
Fellowcrafters, Inc.	Boston, Mass.
*Metal Crafts Supply Co.	10 Thomas St., Providence, R. I.
Plastic Craft Workshop	P. O. Box 127, Rahway, N. J.
Plastic Parts & Sales	1157 S. Kingshighway St., St. Louis 10, Mo.
Patterson Bros.	15 Park Row, New York City, N. Y.
Metal Findings Corp.	150 W. 22 St., N. Y. C. (Findings only; quantity orders; gross lots)
S. Nathan, Inc.	550 5th Ave., N. Y. C. (Precious & semi-precious stones)
Carpenter & Wood	Providence, R. I. (Enameler's supplies only)

SHEET METAL

Weight Per Square Inch by B & S Gauge

B & S Gauge	Thick-in Inches	Fine Silver	Sterling Silver	Coin Silver	Fine Gold	10 K Yel. Gold	14 K Yel. Gold	18 K Yel. Gold	Plat-inum	Palla-dium
		Ozs.	Ozs.	Ozs.	Dwts.	Dwts.	Dwts.	Dwts.	Ozs.	Ozs.
1	.28930	1.60	1.58	1.58	59.0	35.3	39.8	47.5	3.27	1.83
2	.25763	1.43	1.40	1.40	52.6	31.4	35.5	42.3	2.90	1.63
3	.22942	1.27	1.25	1.25	46.8	28.0	31.6	37.7	2.59	1.45
4	.20431	1.13	1.12	1.11	41.7	24.9	28.1	33.6	2.30	1.29
5	.18194	1.01	.996	.992	37.1	22.2	25.1	29.9	2.06	1.15
6	.16202	.899	.887	.883	33.1	19.8	22.3	26.6	1.83	1.02
7	.14428	.800	.790	.786	29.4	17.6	19.9	23.7	1.63	.912
8	.12849	.713	.704	.700	26.2	15.7	17.7	21.0	1.45	.812
9	.11443	.635	.627	.624	23.3	14.0	15.8	18.8	1.29	.723
10	.10189	.565	.558	.555	20.8	12.4	14.0	16.7	1.15	.644
11	.09074	.503	.497	.495	18.5	11.2	12.5	14.9	1.03	.574
12	.08080	.448	.443	.440	16.5	9.85	11.0	13.3	.913	.511
13	.07196	.399	.394	.392	14.7	8.77	9.91	11.8	.813	.455
14	.06408	.356	.351	.349	13.0	7.81	8.82	10.5	.724	.405
15	.05706	.317	.313	.311	11.6	6.96	7.86	9.37	.645	.361
16	.05082	.282	.278	.277	10.4	6.21	7.00	8.35	.574	.321
17	.04525	.251	.248	.247	9.23	5.52	6.23	7.43	.511	.286
18	.04030	.224	.221	.220	8.22	4.90	5.55	6.62	.455	.255
19	.03589	.199	.197	.196	7.32	4.38	4.94	5.89	.406	.227
20	.03196	.177	.175	.174	6.52	3.90	4.40	5.25	.361	.202
21	.02846	.158	.156	.155	5.81	3.47	3.92	4.67	.322	.180
22	.02534	.141	.139	.138	5.17	3.09	3.49	4.16	.286	.160
23	.02257	.125	.124	.123	4.60	2.75	3.11	3.71	.255	.143
24	.02010	.112	.110	.110	4.10	2.45	2.77	3.30	.228	.127
25	.01790	.0993	.0980	.0976	3.65	2.18	2.46	2.94	.202	.113
26	.01594	.0884	.0873	.0869	3.25	1.94	2.19	2.62	.180	.101
27	.01419	.0787	.0777	.0773	2.89	1.73	1.95	2.33	.160	.0897
28	.01264	.0701	.0692	.0689	2.58	1.54	1.74	2.08	.143	.0799
29	.01125	.0624	.0616	.0613	2.29	1.37	1.55	1.85	.127	.0711
30	.01002	.0556	.0549	.0546	2.04	1.22	1.38	1.66	.113	.0633
31	.00892	.0495	.0489	.0486	1.82	1.09	1.23	1.46	.101	.0564
32	.00795	.0441	.0435	.0433	1.62	.969	1.09	1.31	.0898	.0503
33	.00708	.0393	.0388	.0386	1.44	.863	.975	1.16	.0800	.0448
34	.00630	.0350	.0345	.0343	1.29	.768	.868	1.03	.0712	.0398
35	.00561	.0311	.0307	.0306	1.15	.684	.772	.921	.0634	.0355
36	.00500	.0277	.0274	.0273	1.02	.610	.689	.821	.0565	.0316
37	.00445	.0247	.0244	.0243	.908	.543	.613	.731	.0503	.0281
38	.00396	.0220	.0217	.0216	.808	.483	.545	.650	.0448	.0250
39	.00353	.0196	.0193	.0192	.720	.430	.486	.580	.0399	.0223
40	.00314	.0174	.0172	.0170	.640	.383	.432	.516	.0355	.0199

NOTE: Sterling silver stock is supplied in annealed (soft) state, although it may be supplied otherwise if so specified in ordering.

ROUND WIRE

Weight in Pennyweights or Ounces Per Foot in B & S Gauge

B & S Gauge	Thick-in Inches	Fine Silver Ozs.	Sterling Silver Ozs.	Coin Silver Ozs.	Fine Gold Dwts.	10 K Yel. Gold Dwts.	14 K Yel. Gold Dwts.	18 K Yel. Gold Dwts.	Plat-inum Ozs.	Palla-dium Ozs.
1	.28930	4.38	4.32	4.30	161.0	96.2	109.	130.	8.91	4.99
2	.25763	3.47	3.43	3.40	128.	76.3	86.1	104.	7.07	3.95
3	.22942	2.75	2.72	2.70	101.	60.5	68.3	81.5	5.61	3.14
4	.20431	2.18	2.15	2.15	80.3	48.0	54.2	64.6	4.45	2.49
5	.18194	1.73	1.70	1.70	63.6	38.0	43.0	51.2	3.53	1.97
6	.16202	1.37	1.36	1.35	50.5	30.2	34.1	40.6	2.80	1.56
7	.14428	1.09	1.07	1.07	40.0	23.9	27.0	32.2	2.22	1.24
8	.12849	.863	.852	.848	31.7	19.0	21.4	25.6	1.76	.984
9	.11443	.685	.676	.673	25.2	15.1	17.0	20.3	1.39	.780
10	.10189	.543	.536	.533	20.0	11.9	13.5	16.1	1.11	.619
11	.09074	.431	.425	.423	15.8	9.46	10.7	12.7	.877	.491
12	.08080	.341	.337	.335	12.6	7.50	8.47	10.1	.695	.389
13	.07196	.271	.267	.266	9.96	5.95	6.72	8.01	.552	.309
14	.06408	.215	.212	.211	7.89	4.72	5.33	6.36	.437	.245
15	.05706	.170	.168	.167	6.26	3.74	4.23	5.04	.347	.194
16	.05082	.135	.133	.133	4.97	2.97	3.35	4.00	.275	.154
17	.04525	.107	.106	.105	3.94	2.35	2.66	3.17	.218	.122
18	.04030	.0849	.0838	.0834	3.12	1.87	2.10	2.51	.173	.0968
19	.03589	.0674	.0665	.0662	2.48	1.48	1.67	1.99	.137	.0767
20	.03196	.0534	.0527	.0525	1.96	1.17	1.33	1.58	.109	.0609
21	.02846	.0424	.0418	.0416	1.56	.931	1.05	1.25	.0863	.0483
22	.02534	.0336	.0331	.0330	1.23	.738	.833	.994	.0684	.0383
23	.02257	.0266	.0263	.0262	.979	.585	.661	.789	.0543	.0304
24	.02010	.0211	.0209	.0208	.777	.464	.524	.625	.0430	.0241
25	.01790	.0168	.0165	.0165	.616	.368	.416	.496	.0341	.0191
26	.01594	.0133	.0131	.0131	.489	.292	.330	.393	.0271	.0151
27	.01419	.0105	.0104	.0103	.387	.231	.261	.312	.0214	.0120
28	.02164	.00835	.00825	.00821	.307	.184	.207	.247	.0170	.00952
29	.01125	.00662	.00653	.00650	.243	.145	.164	.196	.0135	.00754
30	.01002	.00525	.00518	.00516	.193	.115	.130	.155	.0107	.00598
31	.00892	.00416	.00410	.00409	.153	.0914	.103	.123	.00847	.00474
32	.00795	.00330	.00326	.00325	.122	.0726	.0820	.0978	.00673	.00377
33	.00708	.00262	.00259	.00258	.0964	.0576	.0651	.0776	.00534	.00299
34	.00630	.00208	.00205	.00204	.0763	.0456	.0515	.0614	.00423	.00236
35	.00561	.00165	.00162	.00162	.0605	.0362	.0408	.0487	.00335	.00188
36	.00500	.00131	.00129	.00128	.0481	.0287	.0324	.0387	.00266	.00149
37	.00445	.00104	.00102	.00102	.0381	.0228	.0257	.0306	.00211	.00118
38	.00396	.000820	.000809	.000806	.0302	.0180	.0204	.0243	.00167	.000934
39	.00353	.000652	.000643	.000640	.0240	.0143	.0162	.0193	.00133	.000742
40	.00314	.000516	.000509	.000507	.0190	.0113	.0128	.0153	.00105	.000587

TROY AND AVOIRDUPOIS WEIGHT EQUIVALENTS

Troy weight:* 24 grains=1 pennyweight (dwt.). 20 dwt.=1 ounce (oz.) 12 oz.=1 pound (lb.)

Ounces Troy to Pounds and Ounces Avoirdupois

Ozs. Troy	Lbs. & Ozs. Avoir.	Ozs. Troy	Lbs. & Ozs. Avoir.	Ozs. Troy	Lbs. & Ozs. Avoir.
1	1.1	39	2-10.8	77	5- 4.5
2	2.2	40	2-11.9	78	5- 5.6
3	3.3	41	2-13.0	79	5- 6.7
4	4.4	42	2-14.1	80	5- 7.8
5	5.5	43	2-15.2	81	5- 8.9
6	6.6	44	3- 0.3	82	5-10.0
7	7.7	45	3- 1.4	83	5-11.1
8	8.8	46	3- 2.5	84	5-12.2
9	9.9	47	3- 3.6	85	5-13.3
10	11.0	48	3- 4.7	86	5-14.4
11	12.1	49	3- 5.8	87	5-15.5
12	13.2	50	3- 6.9	88	6- 0.6
13	14.3	51	3- 8.0	89	6- 1.7
14	15.4	52	3- 9.1	90	6- 2.8
15	1- 0.5	53	3-10.2	91	6- 3.9
16	1- 1.6	54	3-11.3	92	6- 5.0
17	1- 2.7	55	3-12.4	93	6- 6.1
18	1- 3.8	56	3-13.5	94	6- 7.2
19	1- 4.9	57	3-14.6	95	6- 8.3
20	1- 6.0	58	3-15.7	96	6- 9.4
21	1- 7.1	59	4- 0.8	97	6-10.5
22	1- 8.2	60	4- 1.9	98	6-11.6
23	1- 9.3	61	4- 3.0	99	6-12.7
24	1-10.4	62	4- 4.1	100	6-13.8
25	1-11.5	63	4- 5.2	200	13-11.5
26	1-12.6	64	4- 6.3	300	20- 9.2
27	1-13.7	65	4- 7.4	400	27- 6.9
28	1-14.8	66	4- 8.5	500	34- 4.6
29	1-15.9	67	4- 9.6	600	41- 2.3
30	2- 1.0	68	4-10.7	700	48- 0.0
31	2- 2.1	69	4-11.8	800	54-13.8
32	2- 3.2	70	4-12.8	900	61-11.5
33	2- 4.3	71	4-13.9	1000	68- 9.2
34	2- 5.4	72	4-15.0	2000	137- 2.3
35	2- 6.4	73	5- 0.1	3000	205-11.5
36	2- 7.5	74	5- 1.2	4000	274- 4.7
37	2- 8.6	75	5- 2.3	5000	342-13.8
38	2- 9.7	76	5- 3.4		

Avoirdupois Ounces and Pounds to Ounces Troy

Avoir. Ozs.	Troy Ozs.	Avoir. Lbs.	Troy Ozs.	Avoir. Lbs.	Troy Ozs.
1	.9115	21	306.250	61	889.583
2	1.823	22	320.883	62	904.167
3	2.734	23	335.417	63	918.750
4	3.646	24	350.000	64	933.333
5	4.557	25	364.583	65	947.917
6	5.469	26	379.167	66	962.500
7	6.380	27	393.750	67	977.083
8	7.292	28	408.333	68	991.667
9	8.203	29	422.917	69	1006.250
10	9.115	30	437.500	70	1020.833
11	10.026	31	452.083	71	1035.417
12	10.937	32	466.667	72	1050.000
13	11.849	33	481.250	73	1064.583
14	12.760	34	495.833	74	1079.167
15	13.672	35	510.417	75	1093.750
		36	525.000	76	1108.333
		37	539.583	77	1122.917
Avoir. Lbs.	Troy Ozs.	38	554.167	78	1137.500
		39	568.750	79	1152.083
		40	583.333	80	1166.667
1	14.583	41	597.917	81	1181.250
2	29.167	42	612.500	82	1195.833
3	43.750	43	627.083	83	1210.417
4	58.333	44	641.667	84	1225.000
5	72.917	45	656.250	85	1239.583
6	87.500	46	670.833	86	1254.167
7	102.083	47	685.417	87	1268.750
8	116.667	48	700.000	88	1283.333
9	131.250	49	714.583	89	1297.917
10	145.833	50	729.167	90	1312.500
11	160.417	51	743.750	91	1327.083
12	175.000	52	758.333	92	1341.667
13	189.583	53	772.917	93	1356.250
14	204.167	54	787.500	94	1370.833
15	218.750	55	802.083	95	1385.417
16	233.333	56	816.667	96	1400.000
17	247.917	57	831.250	97	1414.583
18	262.500	58	845.833	98	1429.167
19	277.083	59	860.417	99	1443.750
20	291.667	60	875.000	100	1458.333

* Precious metals are weighed by troy weight.

NOTE: Silver—sold by the troy ounce. Gold—sold by the pennyweight.

RULES RELATING TO CIRCLES AND OVALS

1. A circle is .7854 times as heavy as a square of the same size, i.e., the loss in cutting a circle from a square is .2146 of the weight of the square.
2. The area of an oval is the longest diameter x the shortest x .7854.
3. The area of a circle is the diameter x itself x .7854.
4. The circumference of a circle is the diameter x 3.1416.
5. The diameter of a circle is the circumference multiplied by .31831.

CIRCLES AND SQUARES

Circumferences and Areas

Size in Inches	Circumference of ○ in Inches	Area of ○ in Square Inches	Area of □ in Square Inches	Size in Inches	Circumference of ○ in Inches	Area of ○ in Square Inches	Area of □ in Square Inches
¼	.7854	.0491	.0625	10¼	32.20	82.52	105.06
½	1.571	.1964	.2500	10½	32.99	86.59	110.25
¾	2.356	.4418	.5625	10¾	33.77	90.76	115.56
1	3.142	.7854	1.000	11	34.56	95.03	121.00
1¼	3.927	1.227	1.563	11¼	35.34	99.40	126.56
1½	4.712	1.767	2.250	11½	36.13	103.87	132.25
1¾	5.498	2.405	3.063	11¾	36.91	108.43	138.06
2	6.283	3.142	4.000	12	37.70	113.10	144.00
2¼	7.069	3.976	5.063	12¼	38.48	117.86	150.06
2½	7.854	4.909	6.250	12½	39.27	122.72	156.25
2¾	8.639	5.940	7.563	12¾	40.06	127.68	162.56
3	9.425	7.069	9.000	13	40.84	132.73	169.00
3¼	10.21	8.296	10.56	13¼	41.63	137.89	175.56
3½	11.00	9.621	12.25	13½	42.41	143.14	182.25
3¾	11.78	11.04	14.06	13¾	43.20	148.49	189.06
4	12.57	12.57	16.00	14	43.98	153.94	196.00
4¼	13.35	14.19	18.06	14¼	44.77	159.49	203.06
4½	14.14	15.90	20.25	14½	45.55	165.13	210.25
4¾	14.92	17.72	22.56	14¾	46.34	170.87	217.56
5	15.71	19.64	25.00	15	47.12	176.72	225.00
5¼	16.49	21.65	27.56	15¼	47.91	182.65	232.56
5½	17.28	23.76	30.25	15½	48.69	188.69	240.25
5¾	18.06	25.97	33.06	15¾	49.48	194.83	248.06
6	18.85	28.27	36.00	16	50.27	201.06	256.00
6¼	19.64	30.68	39.06	16¼	51.05	207.39	264.06
6½	20.42	33.18	42.25	16½	51.84	213.83	272.25
6¾	21.21	35.78	45.56	16¾	52.62	220.35	280.56
7	21.99	38.48	49.00	17	53.41	226.98	289.00
7¼	22.78	41.28	52.56	17¼	54.19	233.71	297.56
7½	23.56	44.18	56.25	17½	54.98	240.53	306.25
7¾	24.35	47.17	60.06	17¾	55.76	247.45	315.06
8	25.13	50.27	64.00	18	56.55	254.47	324.00
8¼	25.92	53.46	68.06	18¼	57.33	261.59	333.06
8½	26.70	56.75	72.25	18½	58.12	268.80	342.25
8¾	27.49	60.13	76.56	18¾	58.91	276.12	351.56
9	28.28	63.62	81.00	19	59.69	283.53	361.00
9¼	29.06	67.20	85.56	19¼	60.48	291.04	370.56
9½	29.85	70.88	90.25	19½	61.26	298.65	380.25
9¾	30.63	74.66	95.06	19¾	62.05	306.36	390.06
10	31.42	78.54	100.00	20	62.83	314.16	400.00

Graphic Arts Section

BY

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INTRODUCTION TO GRAPHIC ARTS SECTION

The graphic arts—writing, printing and picture making—were born of man's innate need to record, preserve, and pass on his acquired knowledge and wisdom. Since the earliest times these arts have been the fostering mother of all mental, spiritual, and cultural progress. Today more than ever, in the many guises of our contemporary high-speed methods of producing newspapers, magazines, and illustrated books, the graphic arts are still the most powerful medium for the dissemination of information, ideas, and beauty.

This book is intended to provide opportunities for the exploration of a selected number of the more significant graphic arts techniques. It will also serve as a guide to the successful practice of these techniques, in the school shop or in a hobby corner. The activities have been simplified to their fundamental principles, so that their practice requires no elaborate mechanical devices or machinery. Painstaking craftsmanship is advocated as the ultimate source of all the virtues inherent in true craftwork: creativeness, industry, initiative and honesty. Through the use of handwork techniques, such desirable habits as accuracy, neatness, concentration, and observation may be acquired.

Techniques and procedures are stressed. No specific subjects or projects are prescribed, so as not to influence unduly the personal inclination or taste of individual students. The subjects for prints which each will select may be determined, to a great extent, by each student's own artistic ability, or by his previous formal art training, or lack of it.

By going back to fundamental principles and coming to grips with the essential problems of each technique, the reader gains a solid understanding of the nature, the development, the potentialities, and the limitations of each method of print making. The procedure will equip him to appreciate more fully the modern, highly developed, industrial version or application of each technique. He who has learned to achieve satisfactory results with his hands and simple tools alone will the more readily apprehend the extent and significance in our daily life of printing and its allied industries.

V. GRAPHIC ARTS SECTION

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Chapter I

LINOLEUM BLOCK PRINTING

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Chapter II

WOOD-ENGRAVING

·

Chapter III

SILK SCREEN PRINTING

·

Chapter IV

BOOKBINDING

FIG. 1.

Chapter I

LINOLEUM BLOCK PRINTING

The History of Block Printing.

In the perspective of the history of graphic reproduction the linoleum block printing of today is merely the streamlined revival of a very old craft. About twelve hundred years ago the Chinese were already taking impressions by hand from carved and inked wood blocks onto crude sheets of paper made from bamboo. The earliest known of these pictures, a genuine block print, is the frontispiece of the Diamond Sutra, or Buddhist Bible, made in A.D. 868. From China through Korea the art seems to have soon reached Japan, and the Japanese wood block printers have been recognized since as the ablest in the world. Even today their prints, made in many colors from carved cherry wood blocks, stand unexcelled.

The earliest block prints to appear in Europe were playing cards reputed to have been made in the first years of the fifteenth century. Crude and somewhat naive pictures of saints and religious scenes followed closely, and before long a few lines of reading matter were cut on the block, much in the style of our present-day captions on illustrations in newspapers, magazines and books. Eventually whole pages of text were cut in blocks, and from these the early block-books were printed. The best known of these books was the *Biblia Pauperum,* or "Poor People's Bible." Wood cutting for printing slowly improved in technique all through the fifteenth century and reached its zenith as an art in the first quarter of the sixteenth century. The works of Albrecht Dürer of Nuremberg in Germany and those of Hans Holbein of Amsterdam mark the highest development of wood block printing in the history of the art. At the time America was discovered block printing was firmly established in Europe as one of the foremost and mature media of expression. From Germany and Holland it rapidly spread to England, France and Italy, exercising in all these countries that tremendous influence upon the development of printing which, in turn, was unquestionably one of the greatest factors in humanity's struggle toward its present civilization.

In the seventeenth century, block printing suffered a sharp decline which, another hundred years later, extended to an actual decay. Two Englishmen, Thomas Bewick and William Blake rescued the craft from its stagnation in the era following the Napoleonic wars. However, from the point of view of artistic conception and excellence of craftsmanship, this revival never reached the heights of the classical period. In quantity of output, however, the nineteenth century was the most prolific of all. Wood cuts, although they were more imitations of line drawings than wood cuts proper, were used lavishly for the illustrative material in newspapers, magazines and books. This flow of commercial block printing was stemmed with the invention of the photo-mechanical methods of reproduction in the second half of the last century. Once more the art seemed doomed to oblivion. However, the inherent vitality of the age-old craft asserted itself again. A few artists here and there carried doggedly on until, a few decades ago, wood block printing once more emerged as one of the recognized and most respected forms of art.

In the contemporary period, block printing can be said to have found itself technically. It has become a medium of expression based not on imitation but once more on its own intrinsic qualities; it has again become a living, creative and original pictorial art, with a mission and a consciousness all its own. The work of our contemporary American artist Rockwell Kent, and others like him, is an index to the heights which present-day block printing has reached.

With all its ups and downs block printing has been for over 500 years the entertainer, the guide and the instructor of the human race. Today it has again become most popular in the comparatively new form of the linoleum block print. When Professor Cisek of Vienna first used linoleum for engraving, he gave the old craft a new impetus that has carried it rapidly to all countries, making block printing once more a cherished medium of expression for the artist-craftsman. Moreover, in this new form it has developed into one of the most useful means for teaching principles of art, as well as the fundamental processes of printing and engraving.

This popularity warrants the prediction of a brilliant future for the time-honored craft. It may be expected to produce an outstanding artist now and then who will set new standards of excellence for the rest of us, and whose prints will be sought by collectors. And unquestionably it will bring increased enjoyment and happiness with enhanced and lasting esthetic values into the lives of the many youngsters who are right now being introduced to its fascination in practically all of our schools.

Designing

Our aim is to create beautiful prints. As a beginner you may perhaps be satisfied at first with copying someone else's work, and this may even be advisible until you have acquired the necessary fundamental skills and techniques. However, very soon you will want to make a print all your own.

Importance of Design.

In your eagerness to get to the actual work of cutting and printing you may be tempted to overlook the importance of adequately preparing your design. However, the facts are that the most careful and painstaking work in cutting and printing can never make up for hurried or slovenly planning. A poor design will yield only poor prints, no matter how finely it has been cut.

To design a print means to make an orderly arrangement of those elements which, within the limits of a process, will produce a harmonious unit that will satisfy your purpose. First, it is necessary that you have a central idea or theme which will integrate into an intelligible whole, that which your print is to express; second, you must know the elements of line, of light and shade, and of color—the building materials of all graphic construction; and, finally, you must be well aware of the limitations that the nature of your material, in this case your linoleum, imposes.

Limitations.

The management of the lines, the masses of black and white, the colors and the textures that make up your picture must be such that you are not attempting the impossible. Very fine lines are hard to cut in linoleum and still harder to print because they soon break, and their use should be avoided. Intermediary tones of light and dark, or halftones, are also beyond the range of our material. We will have to work in broad masses of black and white only. Nor can we express all the minute details that the camera lens records. We shall have to be content to suggest rather than to portray.

In developing designs you may, of course, draw freely on the abundance of illustrative material contained in books, magazines and newspapers. The subject of almost any picture, photograph or drawing may be successfully rendered through a block print, provided it is first translated into the language of linoleum printing by suppressing all superfluous details and conventionalizing individual shapes.

The elements which make up a design, that is, the lines and masses of light and shade, can be executed on the linoleum in three different ways: as black lines on a white background, as white lines on a dark field, or in a combination of these two methods. It is well to keep this important fact in mind when designing a composition. Striking effects can be obtained by the exercise of a judicious choice of these treatments. Study your subject thoroughly. Analyze it and get its dominant note clearly and firmly impressed upon your mind. Then draw your composition on smooth, white paper; outline with a pencil, if you wish, but, in any event, fill in the full design with pen or brush and black India ink. The strokes of a fine brush are particularly well suited to give a visual effect of the design; they come nearest to the particular character of the cut linoleum line.

Do not hesitate to change your design as often as necessary until you have reached the desired effect. A little time spent here will pay dividends in your ultimate results. One good print in your portfolio is better than a host of commonplace or indifferent ones.

Ability to design harmoniously is not necessarily innate; it can be acquired or developed. One of the surest and quickest ways to develop this ability is to collect and study good prints of others. Observe that the best effects are obtained through simplicity of form, economy of detail, and conventionalized suggestion. As your scrap book expands you will also encounter new ways of treating a given subject. Analyzing the work of others, you will strengthen your own feeling of symmetry and proportion in the arrangement of a composition. You will acquire a style and a craftsmanship of your own. There is no rule or formula to teach taste, but if you will consistently exercise your native share of it, it will soon grow into a conscious power.

A few one-color block prints are shown in the illustrations facing this page (Figs. 2, 3, 4 and 5). Study them and note well the characteristic differences between linoleum cut prints and other picture mediums with which you are familiar. Whenever you design for linoleum printing you shall have to submit to the requirements imposed by the limitations of the process.

Block Materials

In comparison with wood, linoleum is a much more easily manipulated substance. It responds to the cutting tools so readily that even the beginner in the art will be richly rewarded for his efforts.

FIG. 2. White outline technique.

FIG. 3. Black outline technique.

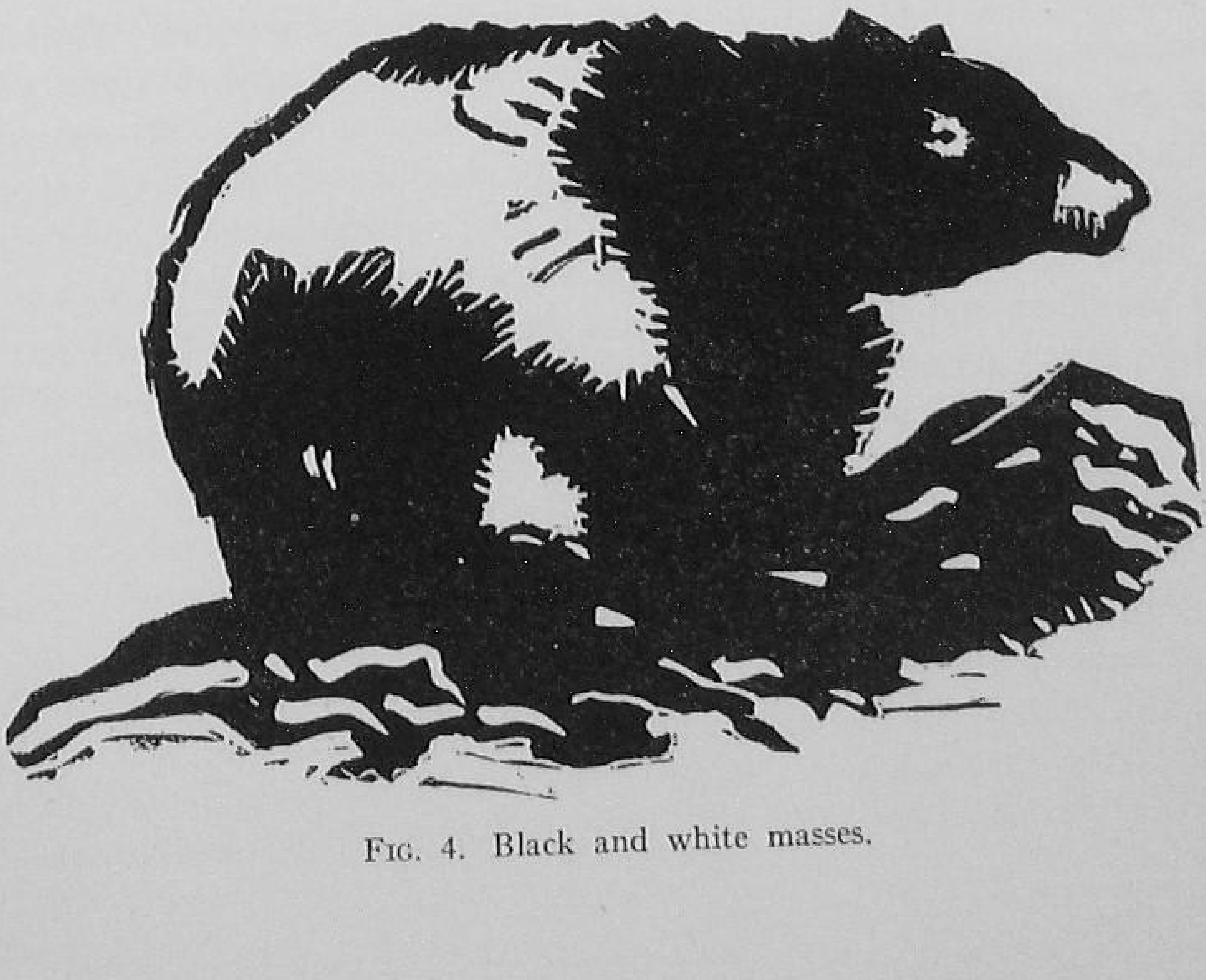


FIG. 4. Black and white masses.

FIG. 5. Combination of white and black lines.

Manufacture of Linoleum.

Linoleum, invented in 1863 by the Englishman Frederick Walton, is made from oxidized or solidified linseed oil to which ground cork and wood-flour are added as fillers and gums and resins as binders. The manufacturing process is quite lengthy. Successive coatings of linseed oil must be spread out daily and left to oxidize until, after several weeks, a layer about ½″ thick has been built up. The sheets are then finely ground and mixed with the fillers and binders to make a thick paste. Machines spread this mixture evenly on webs of special burlap; heat and the pressure of several sets of rollers mold and calender the soft mass into uniformly smooth and hard linoleum.

The condition of the linseed oil used and the mode of oxidizing it, as well as the percentage of cork used for a filler determine the quality of the resulting linoleum. Hence we have varying grades of linoleum, by no means equally suitable to the requirements of our craft. Those with a high cork content are too spongy and soft. While they might be somewhat easier to cut, they would not stand up well under the pressure of printing, especially in long runs. Glazed, inlaid and highly patterned sheets also

are to be avoided; their surface either chips, refuses to take an even coat of ink, or interferes with the drawing of the design or with its cutting.

Battleship Linoleum.

The material best suited for block-printing purposes is called "plain Battleship linoleum." It is manufactured in several thickness of which the $\frac{3}{16}$" and $\frac{1}{4}$" ones are the most desirable. Their greater thickness allows deeper cutting in the larger non-printing areas of the design.

Battleship linoleum may be bought in the bulk from floor covering supply houses or from department stores in sheets 6′ wide; or it may be obtained in smaller pieces in art supply stores. As the pigment is added into the mix during the making of it, it is of a plain, uniform color throughout, generally brown or grey.

Cutting Linoleum.

When handling large sheets, it is well to remember that cold will render linoleum brittle and stiff. Especially in the wintertime it is advisable to lay the sheet on a flat surface until it has warmed up to the temperature of the room. To cut it then, use a knife or a veiner, and score the face of the linoleum as deeply as you can; then break it over the straight corner of the table and sever the strands of the burlap with a sharp knife or scissors. If you have a pair of tinner's snips you can cut the linoleum as with shears. In either case allow a slight excess over the required size, perhaps $\frac{1}{8}$" all around, for finish squaring with the knife or graver.

Mounting Type-high.

If your block is to be printed on a platen press, it must be mounted type-high. It is glued or nailed to a wood base that will bring its thickness up to closely $1\frac{1}{12}$". If the cut is to be printed along with type or type-high material, it must be even more accurately mounted to an exact thickness of .918". A micrometer caliper or a type-high gauge should be used to check this height. Laminated wood or plywood should be used, especially for larger blocks, to guarantee against warping.

To glue your cut or piece of linoleum to a woodblock, coat the wood and the burlap backing of the linoleum with a good grade of glue, press the two together and let dry under a weight or in a clamp.

If you prefer nailing to gluing, use #20 wire nails, $\frac{1}{2}$" long. Place the nails in the cut-out recesses of the design, and use a nail set to drive home the heads of the nails. A hammer blow on the face of your linoleum will

leave a depression in its printing surface that will show in your print as a white spot.

Ready-mounted blocks of perfect type height are available in art stores and school supply houses, in standard sizes, from a single square inch up to 9" by 12". Their cost is slightly higher than that of the materials needed to mount your own blocks.

Some of the ready-made blocks are covered with a coating of Chinese white or other whiting agent. If this is a very thin coat, it is a definite advantage in drawing or transferring a design to the block; but if the coating is heavy, as is almost always the case, it can become a decided nuisance. This layer of paint chips very easily and very unevenly and causes the engraver no end of trouble. In this case the block should be rubbed hard with a cloth and turpentine or alcohol until the white coating has nearly disappeared. This same kind of cleaning should also be administered to blocks or flat linoleum that have been waxed. The wax makes drawing with pencil or pen impossible. Fig. 11 on p. 15 shows pieces of flat linoleum of different thicknesses as well as commercial and home mounted blocks.

Preparing the Block

Fig. 6. Black silhouette.

The Working Drawing.

Your subject may be an object from nature, an animal or the human figure. You may, of course, copy someone else's production if you have had no previous art training, but there is a much greater satisfaction in store for you if you make your own designs.

For a first block print, a simple subject, such as a silhouette like those shown in Figs. 6 and 7, is recommended. In these cuts the effect is obtained through contour outline and formal arrangement in a single plane.

Make a complete drawing of your subject, the exact size your print is

to be, on smooth, white paper, and ink it with black India drawing ink to get the contrasting effect of the finished print. This will be your working drawing. You should keep it close at hand for frequent reference while you are working on your block. Such a precaution becomes almost indispensable once you are handling more intricate designs, especially those for multiple color prints.

FIG. 7. White silhouette.

The Tracing.

From your working drawing, make next a tracing on transparent paper, including in it all the pertinent detail. When you turn this tracing over, you will see the picture in reverse. This is the way it has to appear on the block so that the impressions from the latter will in turn be true reproductions of your original. Failure to reverse your tracing may give disappointing results, especially if you are depicting a subject commonly known by the relationship in space of its parts, such as a landscape or a building. Whenever any sort of lettering appears in the design, reversing becomes absolutely necessary.

If you have no transparent paper available, you may use ordinary writing paper and typewriter carbon paper. Lay the carbon paper on the table, the coated side up; put a sheet of white paper on top of it, and your working drawing on top of this. Trace the detailed outline with a well-sharpened, hard pencil (6H grade), and you will have a reversed copy of your drawing on the under side of your white paper (Fig. 8). As another alternative you may render your original working drawing transparent by rubbing a little oil into the back of the sheet with the tips of your fingers. Your inked drawing will become sufficiently visible through the oiled paper.

Of course, an original composition may be drawn directly on the block, thus dispensing with the labor of making a working drawing and a tracing. However, in spite of the advantages of this procedure, few students will be prepared to follow it in their first blocks. As your experience grows, you

may feel justified in adopting it as your method of working; you may save time and work and preserve much of the freshness and bloom of your designs that is all too often lost in successive transfers.

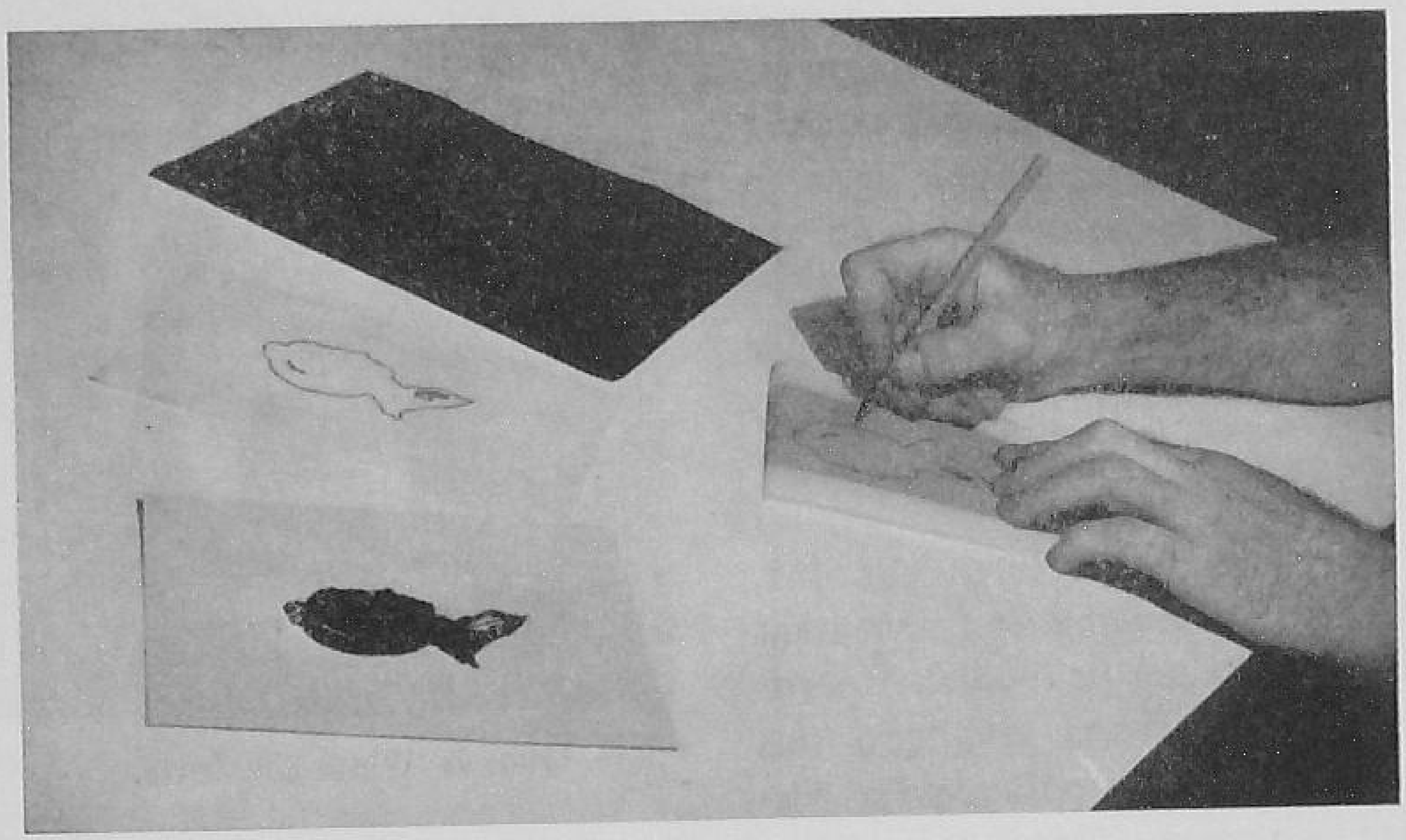


FIG. 8. The working drawing, a tracing from it, and the method of making a reversed transfer to the linoleum.

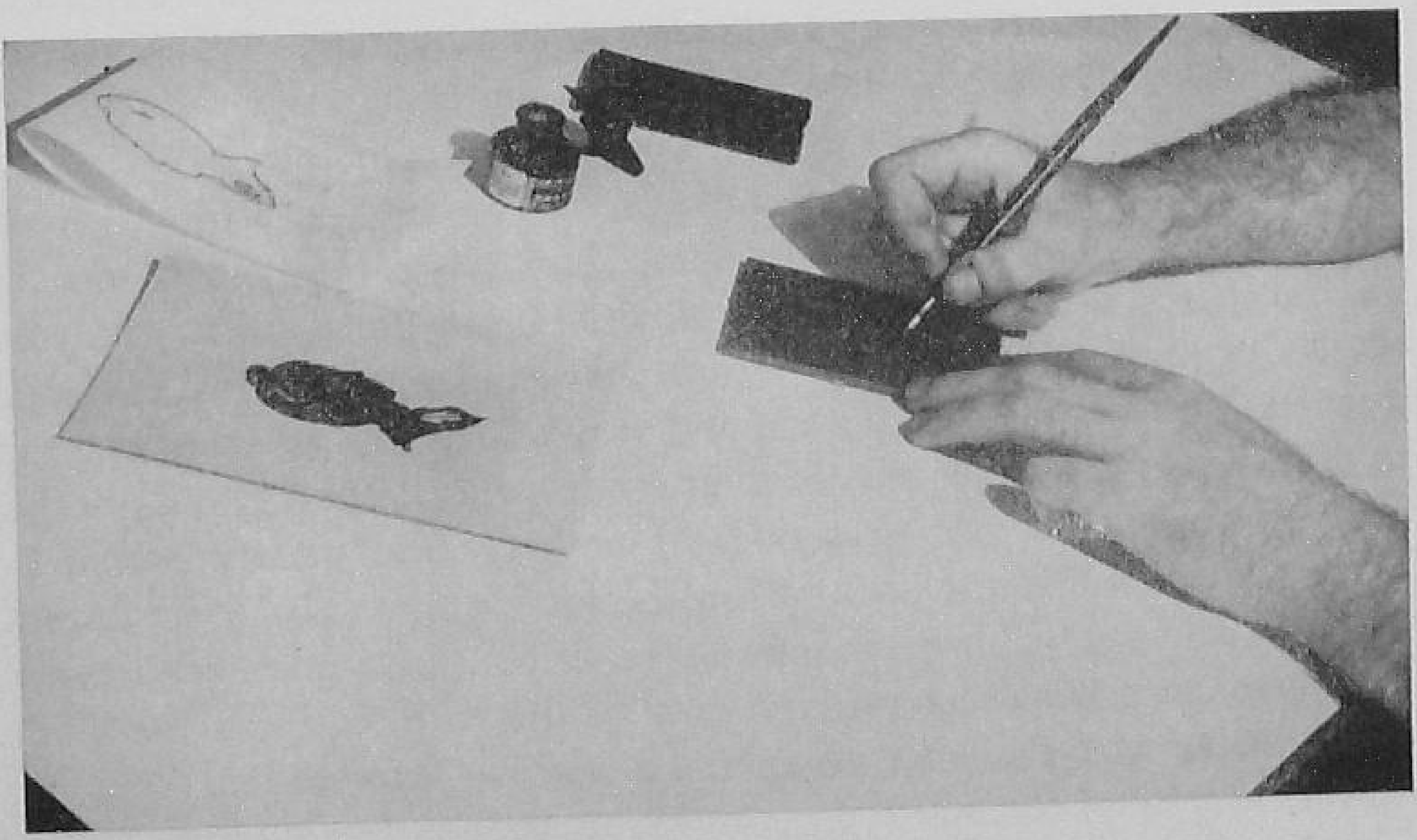


FIG. 9. Inking in the reversed transfer.

Transferring to the Block.

The reversed drawing must now be transferred to the linoleum. The tracing we have just made will enable us to do this. It is merely an intermediary step, and, as such, is exposed to the danger of being treated slightly. If any of the fineness of your working drawing is allowed to be lost in tracing, and another share of it in transferring from this inferior tracing, the result on your linoleum may be considerably below the quality of the original. Do not permit yourself to become careless in either of these two transient operations.

The first step is to cut the linoleum to size, about ⅛" larger in each direction than the outside limits of your working drawing. Commercially prepared mounted blocks present no problem here, but even they should be very closely examined before transferring to them. If the surface is not absolutely smooth, it should be lightly sanded with very fine sandpaper (0000) to remove all grain. Care must be exercised not to sand off the edges and the corners of the block. An oily or waxed film on the face of the linoleum should be removed with a cloth and a little alcohol.

In some cases where the design contains very complicated detail it is advisable to coat the surface of the block with a thin wash coat of Chinese white or white tempera color. When dry, the prepared surface should be a silvery grey rather than a decided opaque, bright white. A heavy coat of white will inevitably chip under the cutting tool and prove more of a hindrance than a help. A similar effect of contrast for the transfer may be obtained by rubbing French chalk or talcum into the face of the linoleum.

Carbon Paper Transfers.

The most commonly followed procedure in transferring is to use the carbon paper that has already served us in making the tracing. Lay it down, carbon side on the face of the block. Put your tracing, face down, on the carbon paper's back, and fasten the whole assembly with either thumbtacks or Scotch tape against the side of the mounted block or on the table in case of flat linoleum stock. If your tracing moves at any time during the transfer, it will be next to impossible to realign it again with any satisfactory degree of accuracy. Trace all the outlines from the back of the transparent paper, using a hard, sharp pencil. A soft pencil leaves an indistinct line; you might lose much of the sharpness of your picture by using it, especially as the carbon line itself has a tendency to spread and blur.

Graphite Transfers.

For this very reason some artists prefer the use of a soft lead transfer to that of the carbon. They finely ink the outline of the design on the back of the tracing to accentuate all its lines. Then they rub the face of the tracing with a very soft lead pencil, depositing an even coat, of graphite. When this is laid down on the lightly sanded linoleum and traced with a hard pencil, the graphite is transferred to the face of the block in clear and sharp lines. This method has the added advantage that the lines are free from the grease contained in the carbon deposit, which sometimes becomes troublesome when the design is being inked in on the block.

Pasted-on Transfers.

Another way of getting your design onto the block is that borrowed from the Japanese wood block printers. The tracing is made on the thinnest rag paper and is pasted, face down, on the block with a water-soluble paste or glue. Great care must be exercised to get the thin sheet to lie perfectly flat and not to tear it. Any wrinkles will of course, result in a distortion of the design. The cutting is done, in this case, through the back of the paper. When the cutting is completed, the block is washed with lukewarm water which will carry the remaining paper away.

Offset Transfers.

Still another method of achieving a good transfer is the "offset" procedure. The tracing is made in non-waterproof drawing ink on a lightweight bond paper. When completed it is laid, face down, on the linoleum block. A piece of clean, white blotting paper large enough to cover the whole tracing is saturated with ordinary household ammonia and deposited on top of the tracing. The ammonia is allowed to permeate the tracing for a few minutes. Then considerable pressure is exerted on the whole assembly. The length of time needed to transfer a clear image depends on the specific qualities of the paper and ink used for the tracing. A little experimenting with the materials you have on hand may be necessary to develop a proper technique. The whole method is based on the fact that the caustic action of the ammonia will release the ink from the paper and transfer it to the block, thus forming an image in reverse. Too much ammonia penetrating through the paper may make the image blurry and indistinct. However, when once the right proportions and time for your particular ink and paper have been worked out, this method yields excellent and accurate transfers. See Fig. 35, page 633.

Inking in the Block.

When a satisfactory transfer has been obtained by any one of these methods, it will have to be inked in with India drawing ink so that its details will not be lost during the prolonged handling to which the block will be subjected when cutting. For a very simple silhouette like the one in the example shown in the various photographs, a single contour line may be sufficient to differentiate between the parts to be cut away and those that are to remain. On more intricate work, however, it is advisable to ink in, in solid black, all the lines and masses that are to be preserved for printing. The time spent on this phase of the work of adequately preparing your block will be well repaid in cutting. You can concentrate then on your cutting technique and feel free from the anxiety of constantly watching your design. It is all too easy, in the maze of lines that makes up a design not entirely inked, to cut away the wrong area at some spot; when this happens, the block itself and all the work that has gone into it so far are ruined.

The inked block will be a reversed replica of your working drawing. The same attentive care that went into the making of your first drawing should be exercised during this inking in of the block itself. Indifferent handling at any stage will detract from the excellence of the final print. Perfect craftsmanship is made up of unceasing attention and fidelity to detail all along the line.

Cutting the Block

Cutting Tools.

Very few tools are really required for the cutting of a successful linoleum block. Some excellent prints turn up every now and then which were made from blocks cut by school children with nothing more elaborate than a penknife. However, the majority of block workers use a small set of tools manufactured for the express purpose; although some very good ones may be readily made at home.

Block-cutting tools for work on linoleum are sometimes erroneously referred to as "gravers." In reality they are nearer in character to the chisels and gouges used in wood carving than to the true gravers employed by metal and wood engravers. They are, indeed, intended to lift out a chip. The shape of the cutting edge determines the width of the line it will incise in the linoleum. Those used for fine lines are called veiners; those that cut a broader line are known as gouges. The gouges are shal-

low, round chisels of various widths. The veiners may be had in either the sharp V shape or with a rounded bottom edge in the shape of a U. The choice between the two shapes is a matter of personal preference. Both sets leave the same clean edge for printing, if properly used. Small, flat chisels are sometimes used to remove large areas of linoleum quickly.

Both the veiners and gouges are available in either graver-type or long, chisel-type handles. The former fit the palm of the hand snugly, so that delicate cutting may be done by merely contracting the hand rather than by pushing from the wrist or the elbow. Fig. 10 shows the tools that make up the average set: a smaller and a larger veiner, three gouges of various widths, and a knife. A good knife belongs in the tool kit of every block worker.

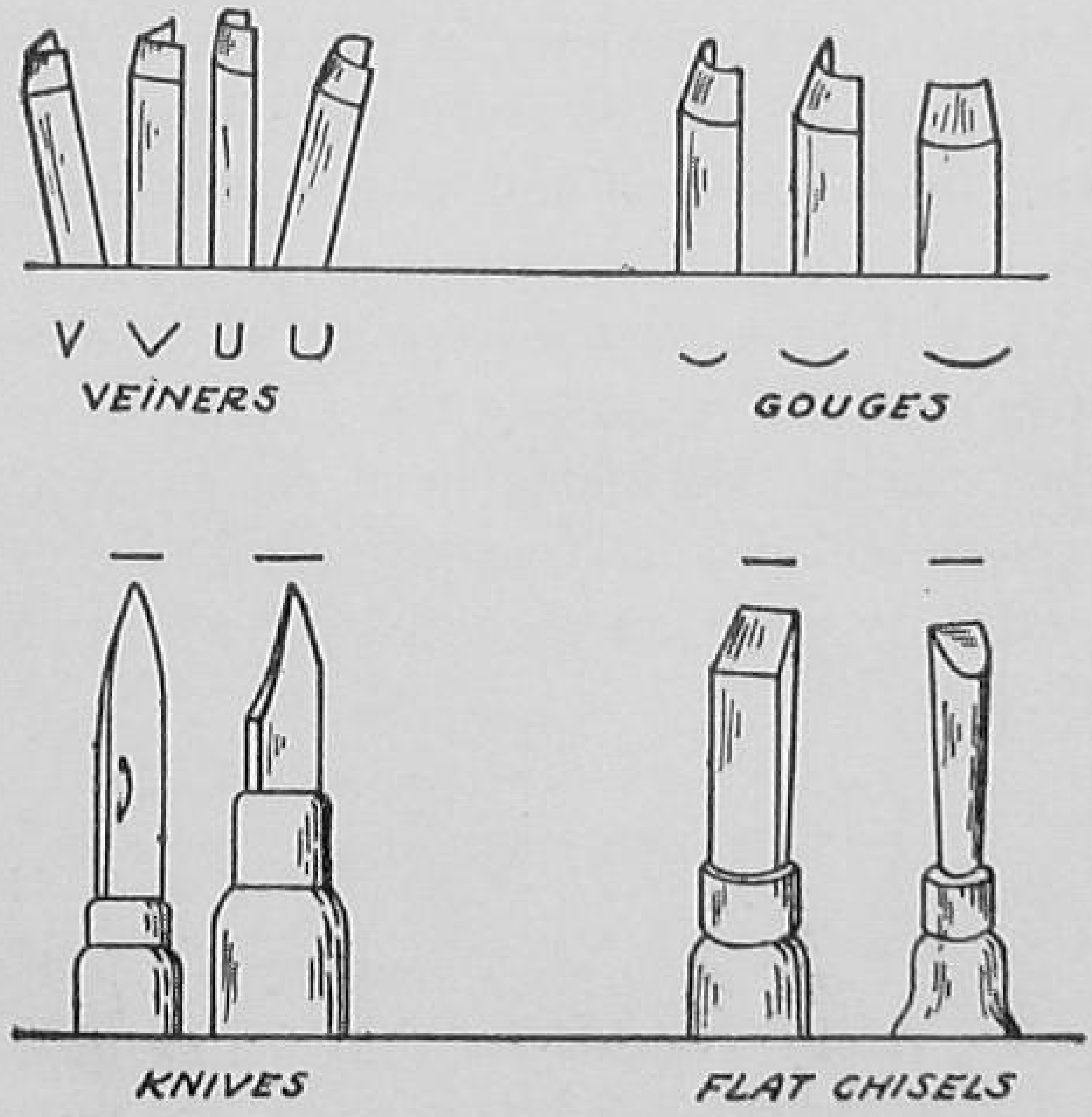


Fig. 10. Linoleum cutting tools.

Other types of linoleum cutters may be obtained from art stores or school supply houses. One particular set is made up of a series of small cutters, in appearance like steel pen nibs, that fit in either ordinary pen-holders or in specially provided handles in which they may be readily interchanged.

Very satisfactory tools may be made at home from umbrella ribs, provided they are made of good steel. Next time a storm turns your umbrella inside out, don't throw it away. Save the ribs, cut them with a hacksaw or a file into 3" to 4" lengths and fasten them into convenient handles of

wood. Sharpen the edge on a grindstone to a beveled edge like those shown in Fig. 10, and finish by honing them on an Arkansas slipstone. Most umbrellas have ribs of two sizes, which will make U-shape veiners as they are. You may make other shapes by heating the cutting tip in the flame of a gas stove, or even a candle, until bright red. Then, either pinch the sides of the rib to make smaller veiners or open them up with round-nose pliers to make gouges. When the desired shape is obtained, heat again to a bright red and quench in water. This will harden the steel again. When sharpened and honed, you will have a set of fine tools to cut many a beautiful block.

In the same vein, a fine cutting knife may be made from an old hacksaw blade. Grind the teeth off, wrap a 3" to 4" length of blade with adhesive tape to make a handle, shape and sharpen the cutting edge, and you have as good a block-cutting knife as money will buy.

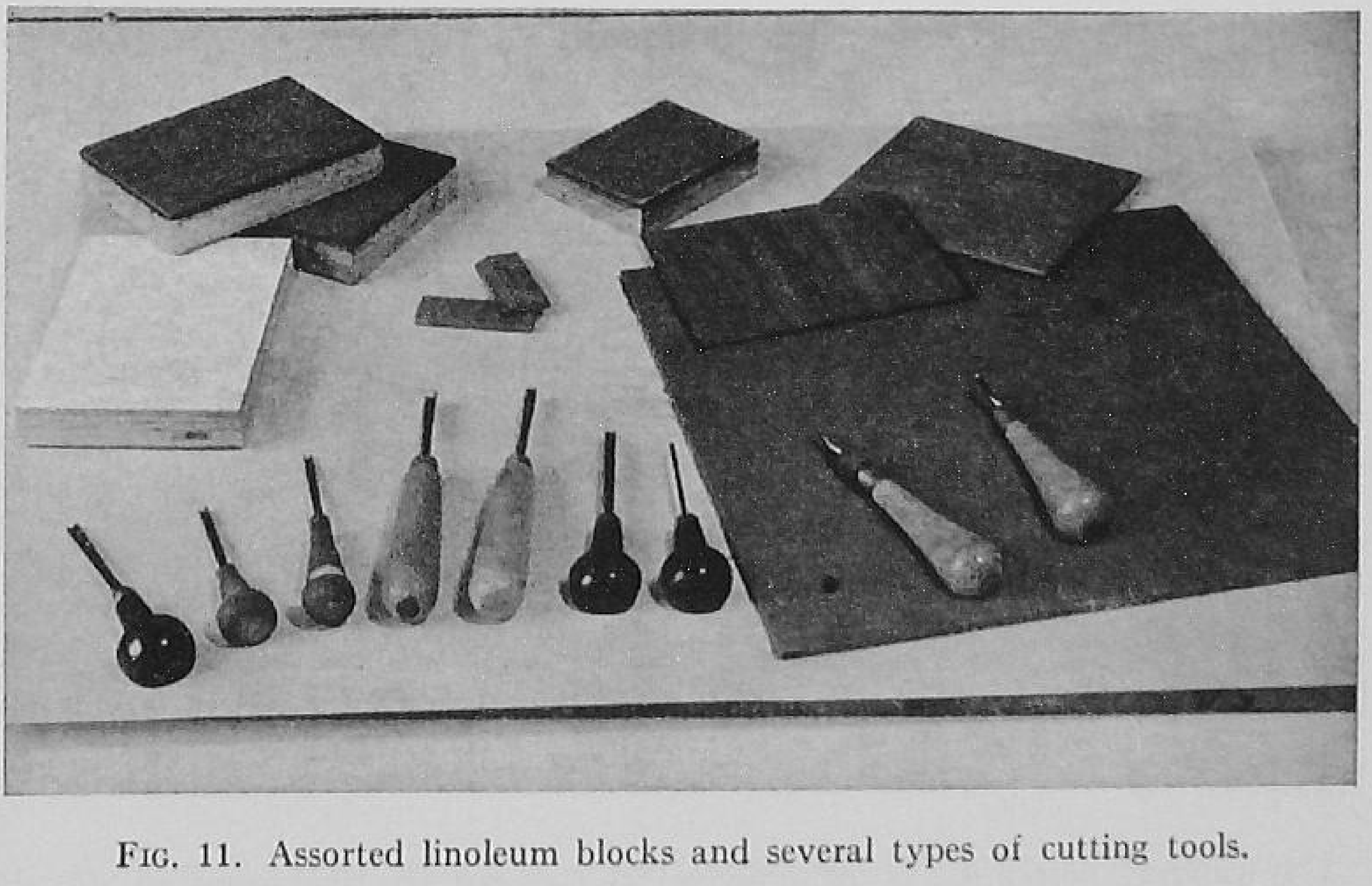


FIG. 11. Assorted linoleum blocks and several types of cutting tools.

No matter what type of tools you select, they should be made of a good grade of tool steel so they will hold a keen cutting edge. Linoleum is a grainy substance that dulls any but the best tools in short order. For this reason a small India oilstone or an Arkansas slipstone should always be kept within easy reach. It is impossible to cut a clean line with a dull tool. As soon as the edge of the tool begins to lose its keenness, so that you

have to exercise pressure to push it through the material, the linoleum is torn rather than cut; the result shows up in your print as a ragged, grainy line. A sharp tool fairly glides through the linoleum.

The Nature of the Cut.

No hard-and-fast rule can be laid down as to the procedure to be followed in cutting a block of linoleum. For the beginner it might be advisable to make at least a few practice cuts on a scrap piece of linoleum in order to acquire a "feel" for the peculiar action of the cutting tools. Try out the knife, the veiners and the gouges by simply cutting a few lines.

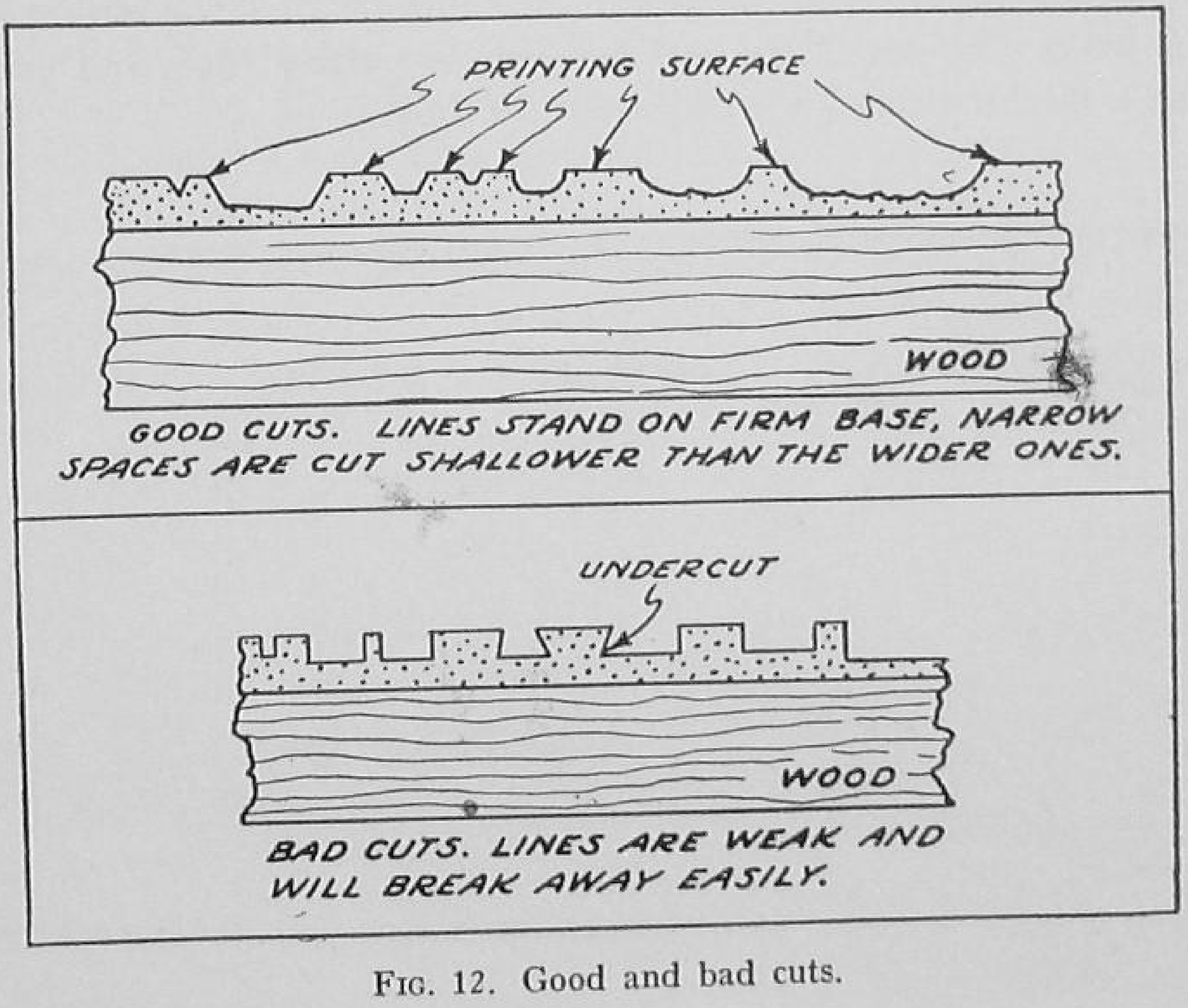


FIG. 12. Good and bad cuts.

The general principle is, of course, to remove the linoleum in all the non-printing areas, that is, in the case of your inked-in block, all the places where the bare linoleum shows around and within the design. Any method that will result in clean-cut sharp lines is legitimate, although each tool leaves to some extent its characteristic mark. The practiced eye can almost always tell whether a cut was executed with the knife alone or with the gouges and veiners.

These latter tools will, by their very shape, leave a filleted shoulder on

the incision that slopes away from the sharp edge of the trimmed line. When cutting with the knife, the blade must be held at a slant, about 30 degrees from the vertical, the point away from the line being cut. In this way the linoleum that is left, that is, the line that will print, remains standing on a firm, downward-broadening base. If the side-walls of the lines were cut at right angles to the face, or even undercut, the line would crumble under the pressure of printing. Fig. 12 shows the cross-section appearance of good and bad cuts, made with either of the tools.

The cutting is done with one hand only, the right, unless you are left-handed. The other hand holds the block firmly down or swivels it to meet the cutting edge when carving curved lines. This other hand should always be kept behind the cutting edge of the tool. When a tool begins to dull, it has a tendency to slip easily out of the linoleum, and disagreeable accidents may occur if your left hand is in its path at that time. No matter how good your control over the tool, keep your left hand out of the way. To help hold a block more securely, it is always best to use a bench hook like the one used in wood-carving. A satisfactory bench hook may be made in a few minutes by simply nailing two strips of wood on a piece of board, as shown in Fig. 13. Some block workers find they obtain better control over their cutting by the use of a sandbag on which to rest their block. This is in general use in wood-engraving. Fig. 37 in the chapter on

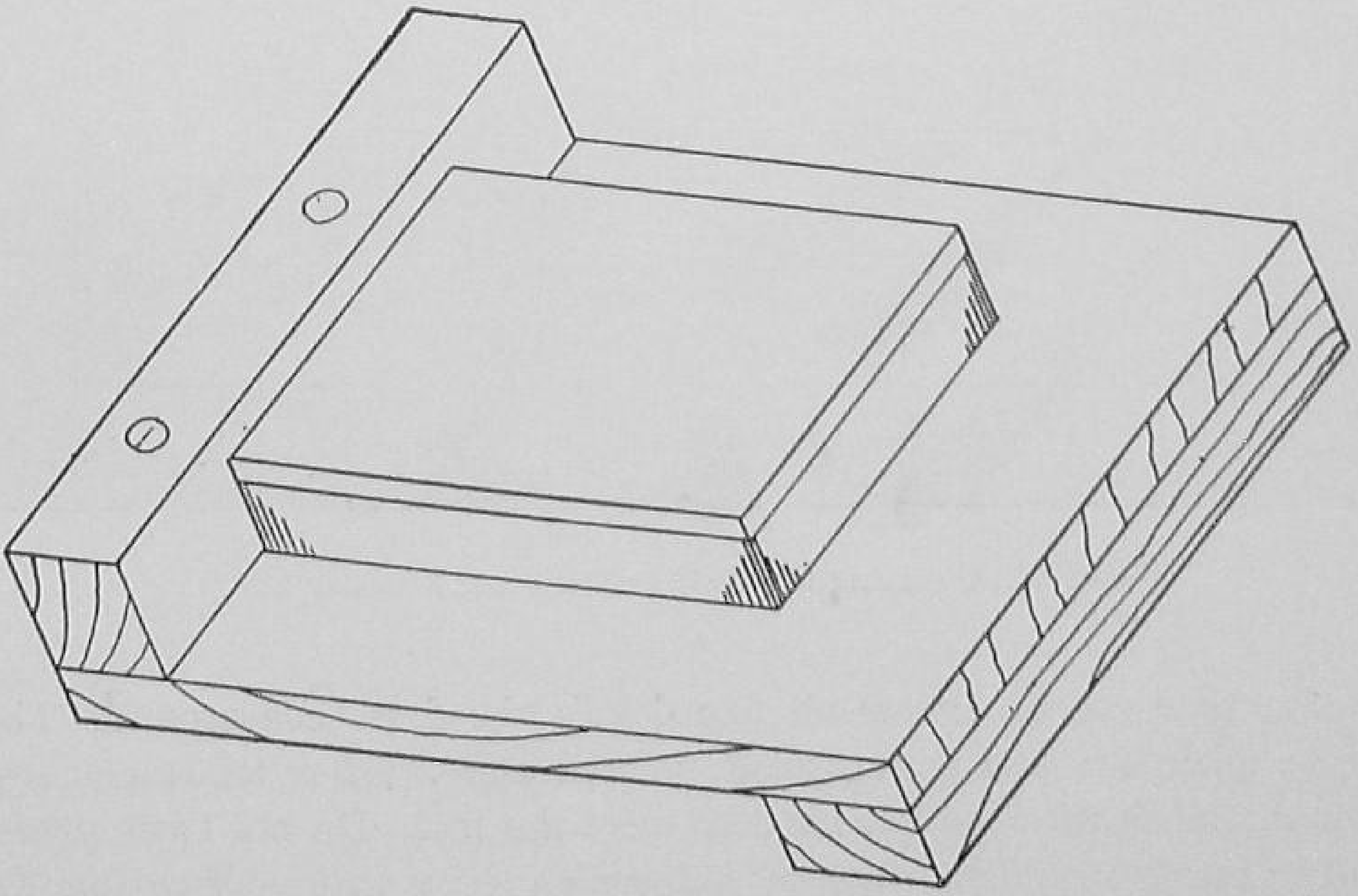


FIG. 13. A linoleum block in a bench hook.

wood engraving shows such a sandbag in use. It may be easily made at home: sew two 7″ to 9″ disks of any firm material, like felt or leather, together, leaving just the last few stitches open. Fill the bag firmly with clean, sifted sand, and sew up the opening.

Except in the case of the knife, all cutting is done away from the operator. With the knife it is better to pull toward you. Here, too, the left hand should be kept in back of the cutting edge at all times.

Cutting the Outline.

The most commonly followed procedure is to outline the design first all around, using the small veiner or the knife, with a trench about 1/16″ wide. The veiner will cut this trench with one stroke, whereas the use of the knife requires two opposite strokes to achieve the same result. See Fig. 14. All areas and lines to be removed should be thus outlined on all sides. Do not attempt to cut deep or with a wide cut. Accuracy is much more im-

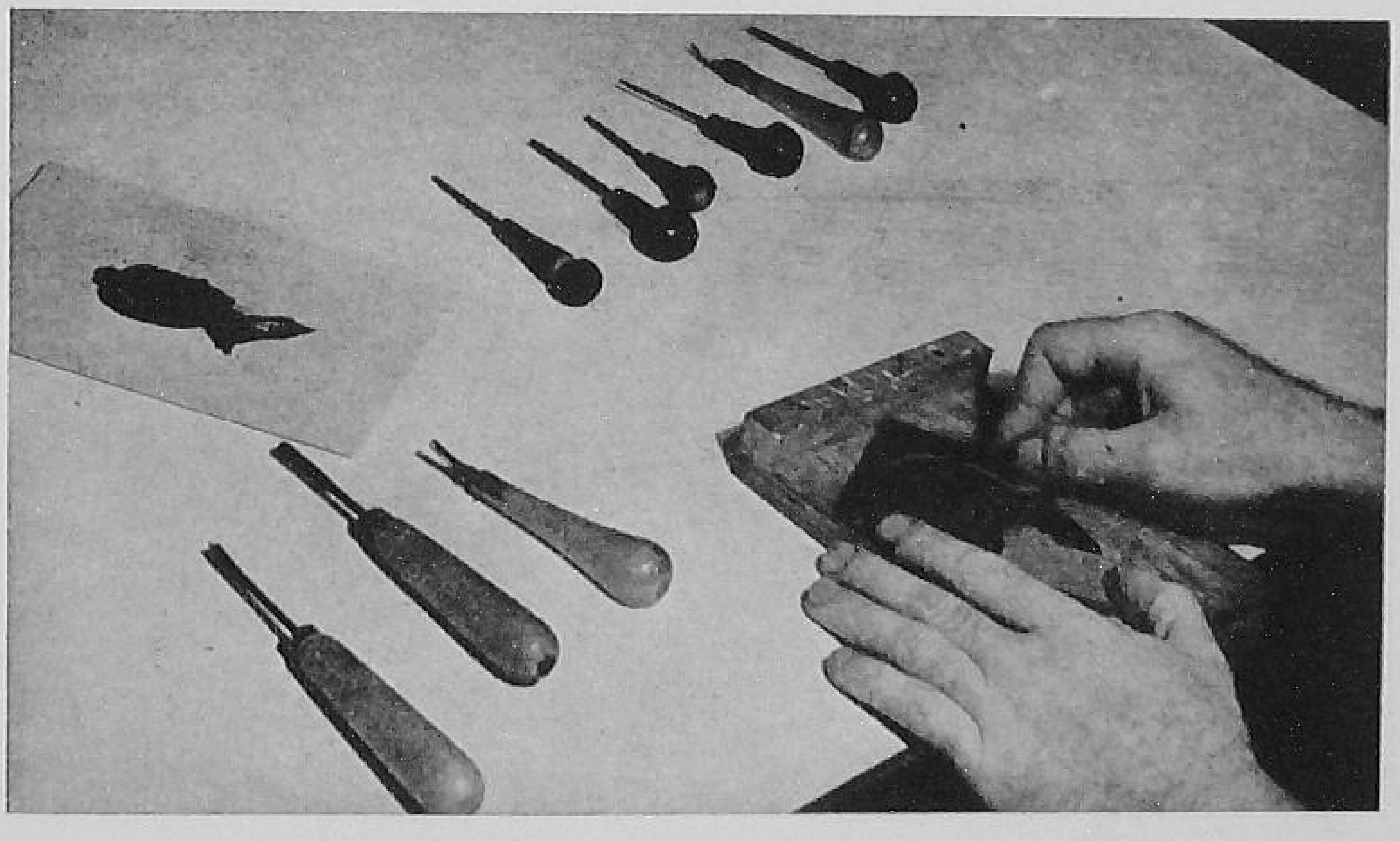


FIG. 14. Outlining the design with a small veiner tool.

portant than speed. Ignore all fine details the first time around. These can be taken out later with a small, pointed knife. When following curves, turn the block with the left hand to meet the tool. Do not twist yourself into an uncomfortable position by following a shape with your cutting hand beyond easy reach. Eagerness to do it quickly may result in your loss of

control of the tool and prove disastrous. Uniformity of line and precision in all the details of the contours are the marks of true craftsmanship.

Be careful not to bruise the sharp outline of the trimmed edge of a printing line when starting another cut closely and at right angles to it. An attempt to dig to the full cutting depth at such a point may force the heel of the tool to depress or nick the already cut edge. Start your cut shallow and turn the block around to clean the trench out from the opposite direction.

The deeper the stroke, the wider the incised line. However, if the tool is forced into the material to the limit of its capacity the edge of the line will not be clean-cut, but will show ragged and torn. Here, also, restraint and patience are preferable to hasty and indifferent work.

Routing the Block.

Now that you have outlined all the printing areas with this shallow and narrow trench it is advisable to widen and deepen this first cut with another, larger tool. Go once more all around, keeping the inside cutting edge of the larger tool in the center of the first cut. When this is completed, all that remains to be done is to route the larger areas to a greater depth. Narrow areas need only a shallow cutting, but the wider non-printing spaces must be cut increasingly deeper towards their center, where you may have to go down to the burlap backing of the linoleum. For this routing out, use your gouges. The irregularity and roughness that the successive gouge strokes may leave on the bottom of these "bowls" do not matter, provided no sharp ridges remain to take on ink and so produce a smudgy print.

Testing the Work in Progress.

You may feel the need to check the progress of your cutting work before the block is entirely finished. If you do, roll it up with an inked brayer to take an impression on paper. The uncut parts of your drawing on the block would be obliterated by the printing ink; this, of course, would not matter once you have completed your outlining, and in this case you could follow this method without hesitation. In the course of the outline work, a good way to preserve the drawing intact and yet view the work done is to rub French chalk, or talcum, or even white flour into the block. Wipe the surface clean, leaving the white powder in the cut-out lines. The black of the inked-in printing areas will show up in sharp contrast with the whitened hollows and allow you to view your work

critically. The chalk or flour may be removed again by simply tapping the back of the cut, while holding it over a waste receptacle.

Cleaning.

When all the cutting has been done, the face of the finished block should be cleaned. The drawing ink used to ink in the transfer must be removed. This cleaning must be done very gently, as any hard rubbing of the printing surface, with its sharply defined delineations, will cause irreparable damage. A soft cloth and warm water with a little soap should dissolve most inks. If waterproof ink was used, a little alcohol should loosen it. Under no circumstances should you scrape the printing surface with any sharp tool, not even with you fingernail. Your block is now ready for proofing.

Printing

There are a number of devices that may be used to print a linoleum block, depending on the equipment available. The object of any of them, whether a standard production printing press or a simple home-made jig, is to secure the necessary pressure to produce a clean print. If your first prints do not come out to your entire satisfaction, do not be discouraged. Study your problem again and find the flaw in your set-up. Mastery will come with thorough understanding of principles, coupled with skill acquired in handling the materials.

Inking the Block.

No matter which printing method described hereafter you plan to use, you must first get an even coat of the right kind of ink on your block.

Inks suitable for linoleum printing are many and varied. Art supply houses sell already prepared linoleum block printing inks put up in small tubes and in many colors. They may be made either from an oil-varnish base or from a water-color base. Regular printer's ink, by far the most commonly used, may be bought in ¼-pound tubes or 1-pound cans directly from ink manufacturers or through the various paper houses that supply commercial printers. For our purpose, a soft book ink, or a so-called job ink, should be chosen. Bond ink is too stiff. Even the job ink may require some thinning out with either reducing varnish or a very few drops of turpentine.

Unlike liquid writing ink, all these inks are in paste form. For use they must be rolled out on an ink slab. A square of plate glass about 10″ x 10″,

a glazed tile, or even a sheet of zinc or aluminum will make a satisfactory ink slab. The ink will not penetrate into any of these materials, and they may be easily cleaned when printing is over. Never let ink dry on the ink slab. While still wet it may be readily wiped off with a rag and a few drops of kerosene oil.

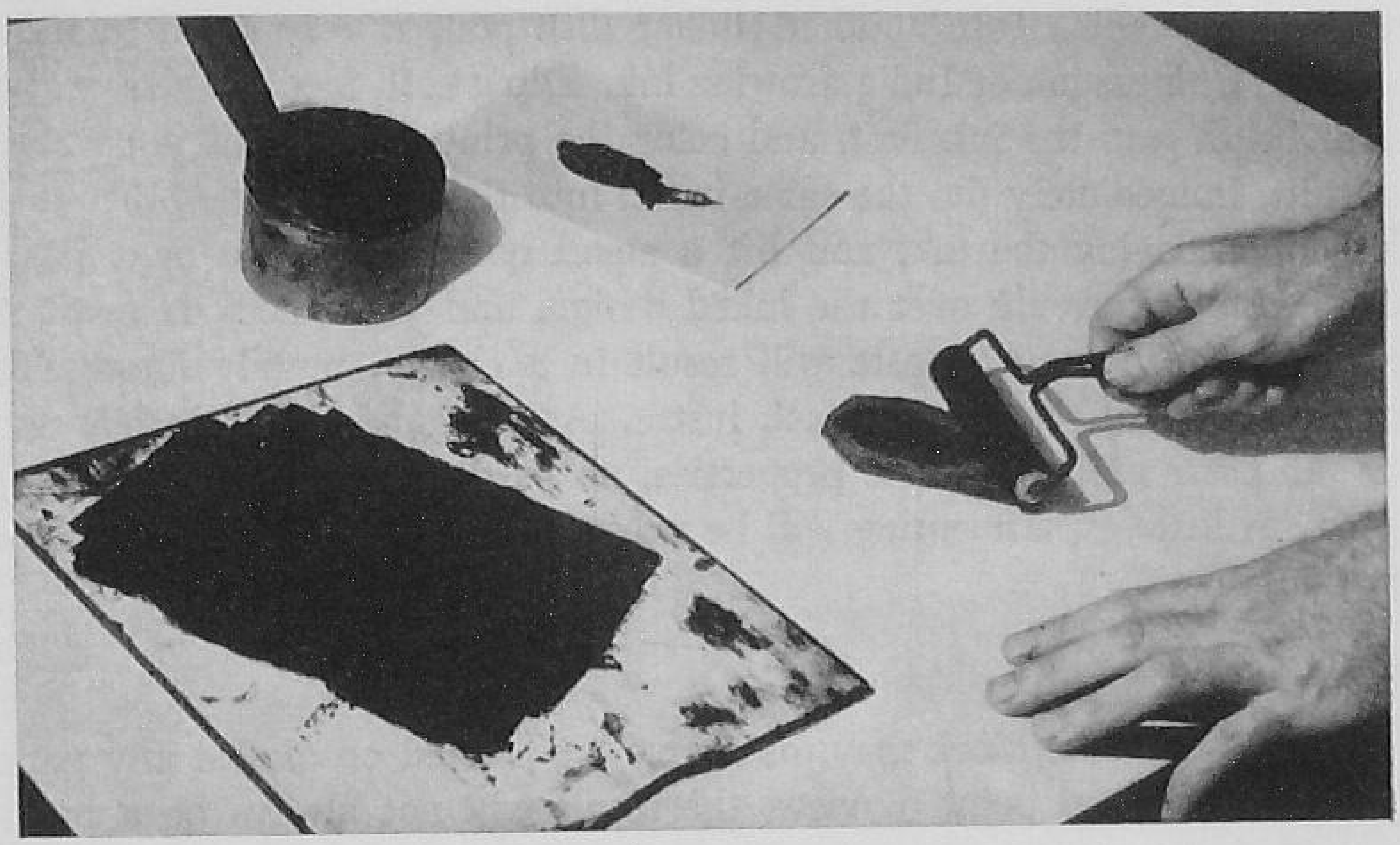


FIG. 15. Inking the cut with a brayer.

To work up your ink on the slab, squeeze from the tube or lift from the can an amount of ink about the size of a large pea. This will be sufficient for quite a number of prints. Place the paste near the end of the slab. Run the brayer back and forth over it and distribute the ink over about one half the surface of the slab. Then run the charged roller over the still clean half of the slab, thus working up a very thin and even coat of ink, in which all the fibers are well broken up. The first half, where the film is heavier, acts as a sort of reservoir. For each inking of the block, charge the roller by passing it over the first half of the slab; then even the charge out by rolling it over the other half. From there pass the roller over the block, running it first one way and then at right angles, so as to be sure to cover all the relief parts with an even coat. See Fig. 15.

Home-made Ink.

If for any reason you cannot obtain prepared ink, it is possible to make your own. In a saucepan moisten about two tablespoonfuls of rice flour

if it is available, or, in its absence, ordinary wheaten flour, with just enough cold water to make a paste of the consistency of thick cream. Pour half a pint of rapidly boiling water into the paste and stir. Keep stirring while you let the whole come to a boil. Then pour into a clean receptacle and let cool. This paste is the base of your ink. Put a small quantity of it into a shallow dish, such as an old saucer, and place this on the printing table. Into another similar dish pour a very small quantity of liquid Chinese ink or India drawing ink. Dip a soft, medium-size, water-color brush into the ink first, and color the printing parts of your block with it. Immediately dip the same brush into the paste in the other dish, without removing the ink, and lift a small quantity of the flour paste. Brush this out evenly over the inked design, and your block is ready to be printed. Too much paste will result in a cloggy, muddy impression, and the color of the ink will lack lustre. As inks and the materials used for the paste are of variable properties, no hard-and-fast formula can be given. A little experimenting will be necessary to arrive at the right proportions.

Paper.

While a linoleum block may, of course, be printed on almost any paper from a mechanical point of view, the result will not always be a happy one. To bring a block out to its best advantage the paper must be suited to the technique, that is, to the particular characteristics of the linoleum medium.

Coated and highly calendered papers will not only accentuate any actual defects in the execution of the block, but they will also emphasize the inherent roughness of the medium itself in even the best-cut blocks, and impart to them an appearance of crudeness. Hard-surfaced or highly sized papers, such as Bonds and Writings, are also unsuited. As the ink cannot penetrate into the paper, it is squeezed to the outsides or edges of the printing areas when the pressure is applied, where it then appears as a dirty, indefinite outline of a more intense shade.

Thin, tough Japanese papers are the best, but their cost is relatively high, and they are hard to obtain these days. In the range of our domestic commercial printing papers, the ones best adapted to our purpose are those with a soft, velvety finish, sold by paper houses under the name of antique papers or eggshell finish book papers. Choose a 50- or 60-pound stock, as thin paper is much more workable than the heavier weights.

Some companies sell certain grades of antique finish papers under the special name of linoleum block print paper, in different colors and textures. The color of the paper may have an influence on the character of the print. Paper manufacturers will gladly send sample swatches of their wares to anyone requesting them. You should get some of them into your files and become acquainted with some of those more readily available in your particular locality.

Paper Conditioning.

Printing on paper as it comes from the supply house is, of course, the most expedient way. However, most papers will yield appreciably better results if they are conditioned for printing in the following way: moisten several sheets of clean blotting paper at least as large or larger than your sheet size. Lay three or four sheets of your printing paper on top of one of the moist blotters, then another moist blotter and another layer of paper, and so on, until all your paper is interleaved with these moist blotters. Put a heavy weight on top of the whole pile and leave under pressure for several hours or, if possible, overnight. You will find the paper considerably more receptive to the ink when you print.

Printing on a Platen Press.

Whenever a platen press of the type described in the letterpress section is available it should be used as the best-suited means to obtain the necessary pressure for a good and uniform impression. The blocks for this printing must be type-high, and they will have to be locked up in a chase. See Fig. 25. They are, in all respects, treated in exactly the same way as a printing form made up from type and spaces, as described in the chapter on letter-press printing.

Printing on Specially Made Linoleum Presses.

Several small printing devices have been developed and are offered as so-called block printing presses. One such device, made entirely from hardwood, is shown in Fig. 16. It uses an eccentric cam action in the handle to develop a good amount of pressure, and has thumbscrews on three sides of the bed to hold a block securely in position while printing. These presses sell for a relatively low price, or they can be cheaply made in the home workshop. Other types of similar presses are manufactured by various houses and are generally shown on the pages of catalogs dealing with

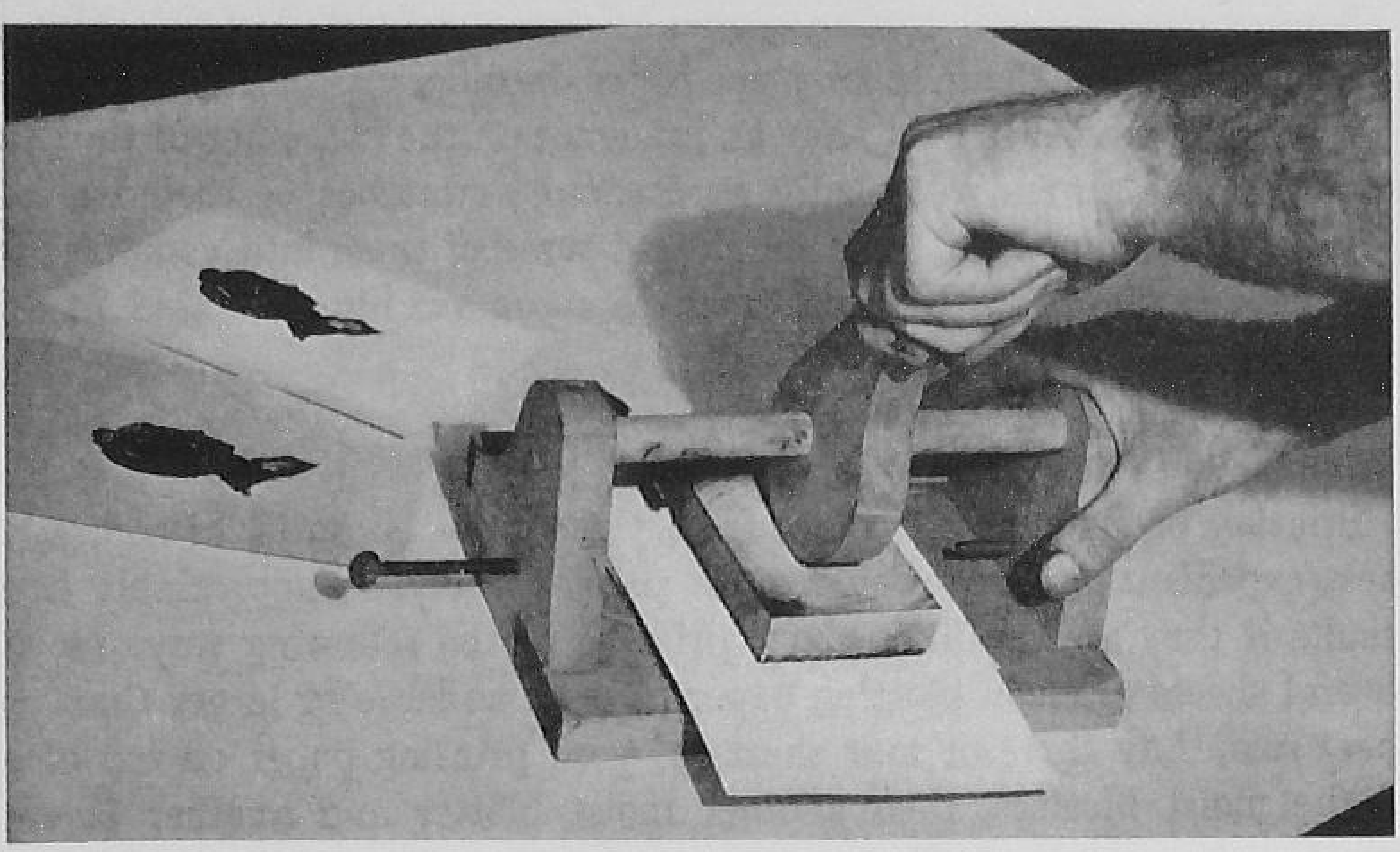


FIG. 16. Printing with a wooden block print press.

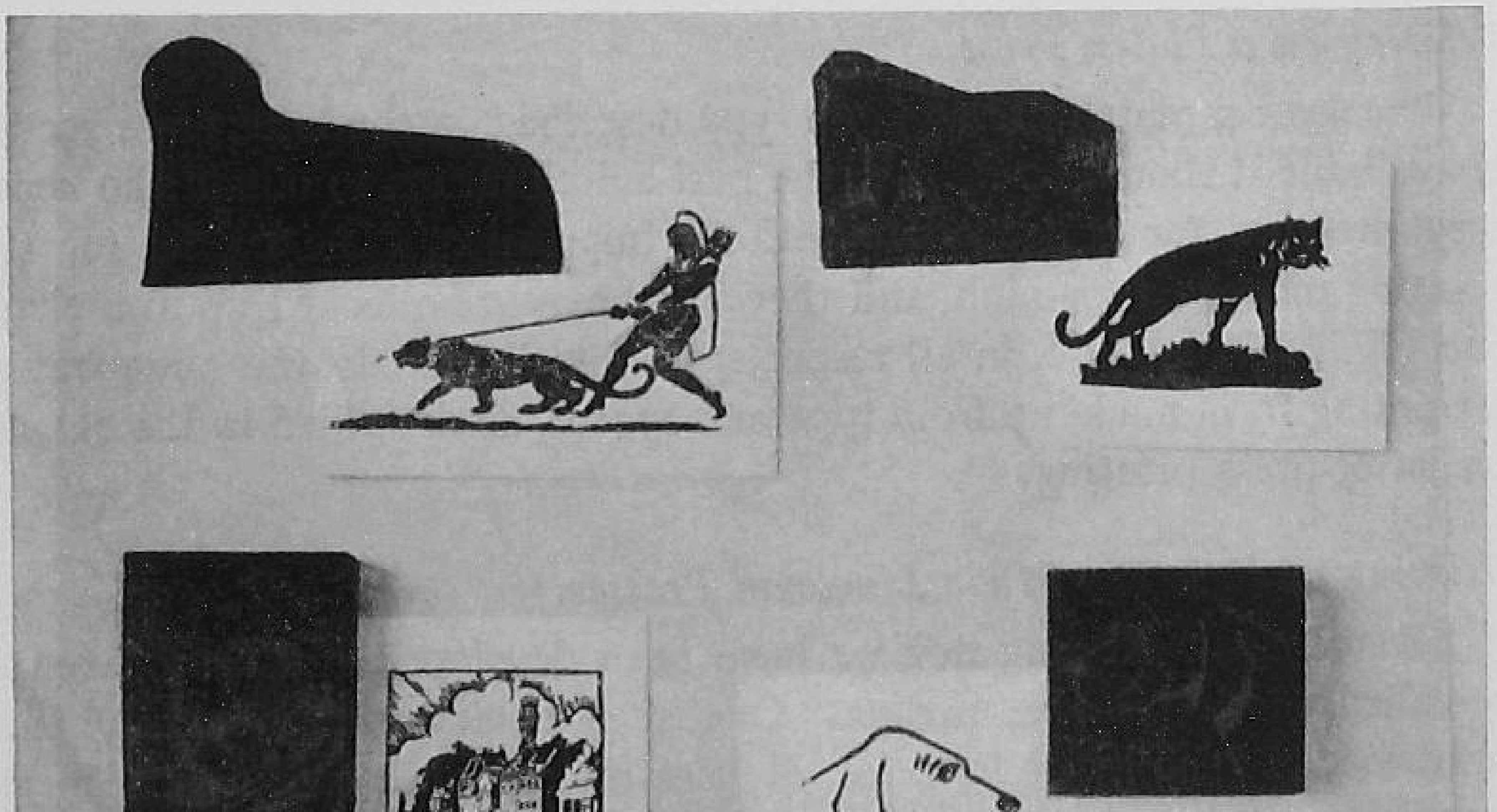


FIG. 17. Four black and white designs, showing the cut blocks and prints taken from them.

block printing supplies. The serious block printer will want these catalogs in his files; much may be learned from them regarding equipment and materials available. All houses ship any of the goods by parcel post. The prospective block printer who lives far removed from the city stores need not miss any new development in equipment or supplies for very long.

Printing Without a Press.

In the absence of any of these specifically prepared devices the artist can still use a number of ways to get good prints from his blocks. In fact, any contrivance which will apply sufficient pressure may be used. If this pressure can be mechanically regulated the results will be more uniform. If not, more of the responsibility for a good impression is left to the skill and deftness with which the makeshift printing devices are handled. To many enthusiastic workers this challenge may be more of an incentive than a deterrent. Some of the more commonly used hand-printing methods will be briefly described. They are given in the nature of suggestions rather than as an attempt to provide a complete list. The artist's own ingenuity may lead him to invent others from the resources of his own surroundings or observation.

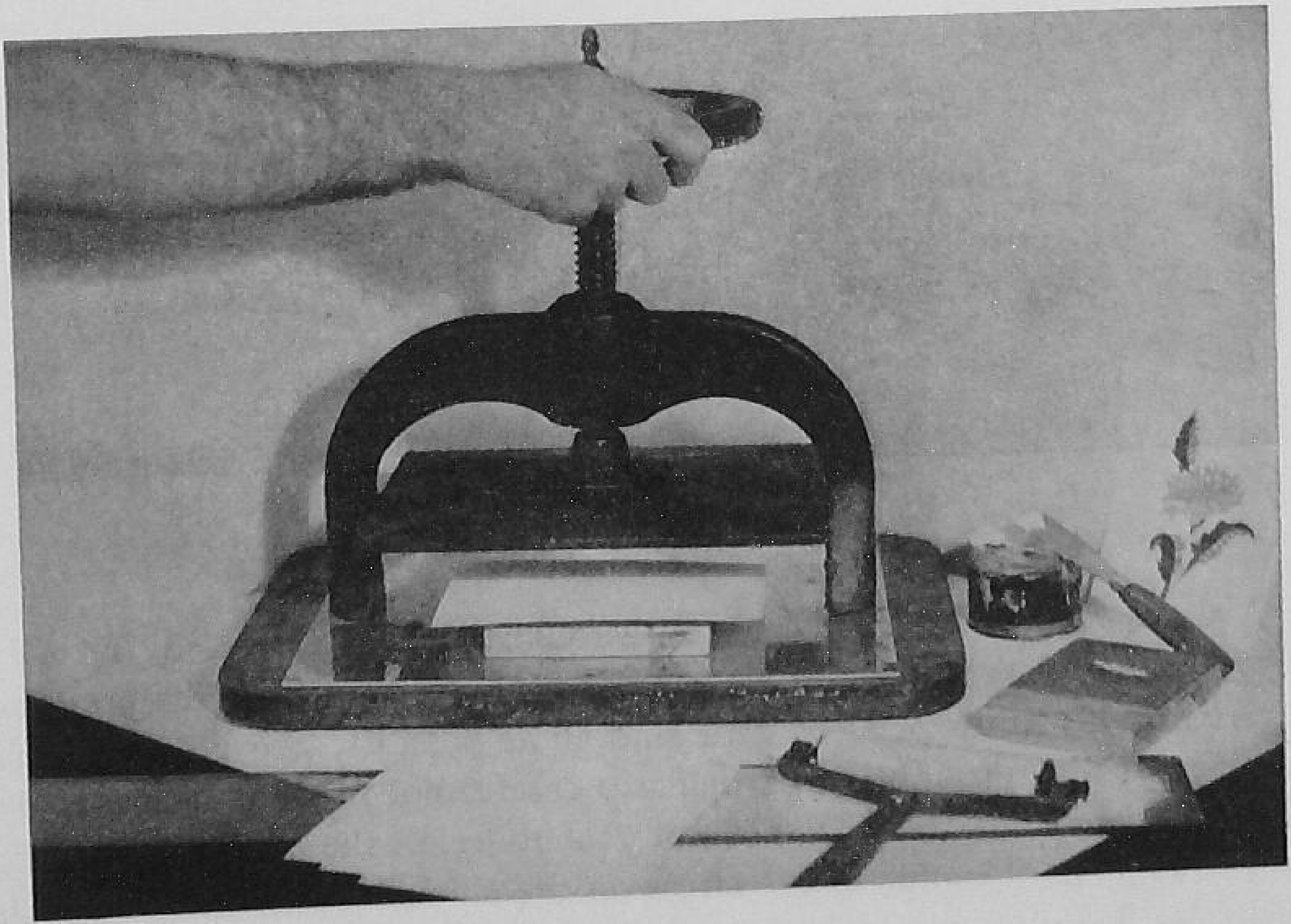


FIG. 18. Copying press.

A letterpress or copying press of the type used in offices for copying letters and invoices before the advent of the typewriter and carbon paper may be used. See Fig. 18. Once in a while one of these may be discovered in the attic or back storerooms of some country stores. They can usually be bought very reasonably and make excellent printing equipment for the amateur. With the aid of a printing jig of the type described under Printing of Color Blocks, they will register complicated prints with perfect accuracy. For printing single-color blocks a somewhat similar jig should be made to prevent rocking of the platen whenever a small block is not perfectly centered under the screw. Such a jig is shown in Fig. 18. The two strips on its side should be exactly the same height as the linoleum being printed. All packing should extend from the block to cover both these strips.

If a sheet of flexible zinc is used for the base of the jig and only flat linoleum is used for the cuts, an old clothes wringer will make a good printing press substitute.

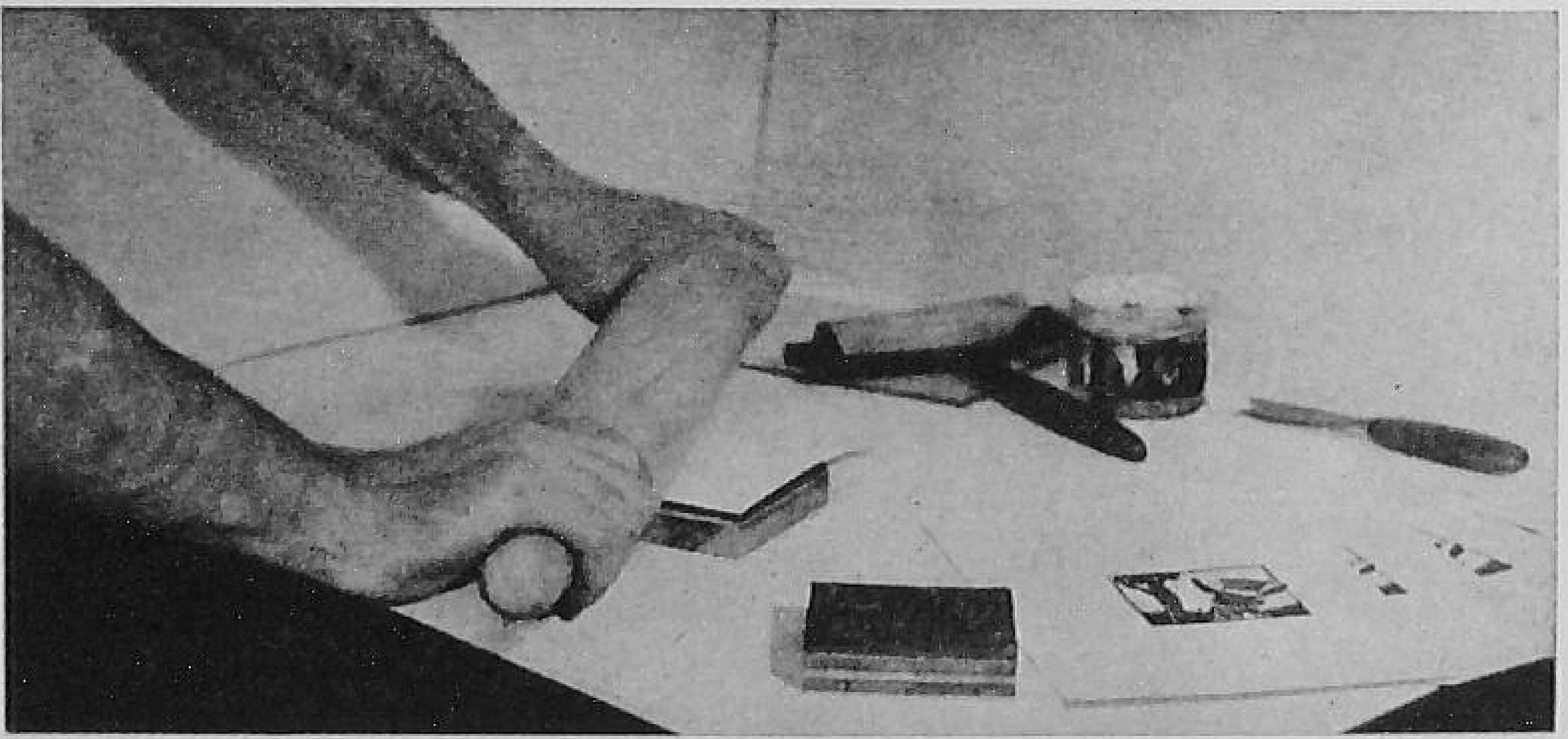


FIG. 19. Pressure from a rolling pin.

A single hard-faced roller, such as a rolling pin, may be used, but this requires more delicate handling on the part of the printer, as the pressure applied by his hands must be kept as even as possible. See Fig. 19. Roll in different directions, being particularly careful not to shift the paper on the block while doing so. Do not run your roller off the edge of the block at any time, as this puts undue stress on the outside lines and may crush them.

The weight of the printer's own body may supply sufficient pressure for satisfactory printing. Place your inked block on a hard paper magazine --one of cheap, pulpy paper will be found too soft. Lay another block over the printing paper, smooth face down, and stand with one foot on the pile, resting all your weight on this foot. Here again, caution should be exercised not to rock the assembly. The same jig may be used to obtain register for color prints. Foot-pressure printing is shown in Fig. 20.

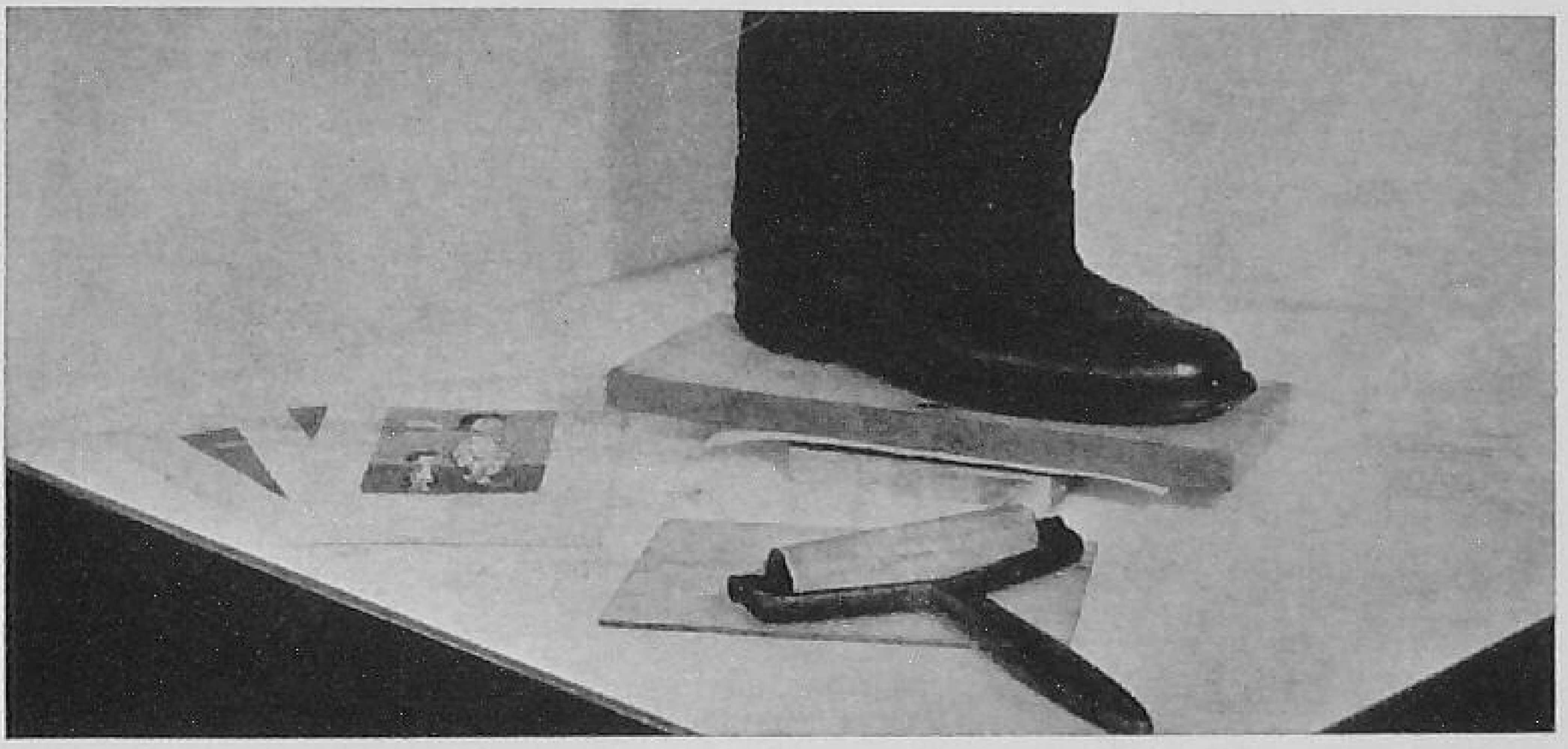


FIG. 20. Foot pressure.

The next and last method—but certainly not the one of last resort—is in universal use among the great number of Japanese wood block printers. On your inked block lay a sheet of your conditioned printing paper, and on top of this one or two sheets of the same paper which is dry. Then rub a "baren" over the back of this paper in a zig-zag motion, exerting an even pressure all the while with your hand. After a little practice you will find that this pressure need not be very great to get prints of intense and even color. A baren may be made as follows: make a coiled disk of string by rolling the string and sewing it together here and there to a diameter of about 3″. On this coil lay a disk of stiff cardboard of the same size. Wrap the two in a double or triple layer of silk, stretching the silk tightly over the cord-coil side and assembling it into a handle on the opposite or cardboard side. The underside or rubbing face must be drawn very smooth so that the silk is not folded at the edges. Two or three thicknesses of discarded silk or nylon hose will do fine for the silk covering. The Japanese use a soaked bamboo leaf, to cover their baren, but as these are hard

to find in this country the silk will make a satisfactory substitute. Trim the handle and wrap several layers of string or twine around it so that it will stand upright and leave no floating ends to get under the face.

If you are too impatient to construct a baren you may get a fair impression from your block by rubbing the back of the paper with either the handle or the bowl of a spoon until it has passed several times over all the area.

For small blocks a woodworking C-clamp or even a vise may provide the printing pressure.

Handling Wet Prints.

Whatever your method of printing, do not stack your wet prints too high, as they may either smudge or offset to the underside of the next sheets, or, as is generally the case, they may do both. Whenever it can be done, prints should be spread out to dry in the open air. Oil-base inks dry through oxidization of the linseed oil, and this process is greatly hastened whenever the printed surface can be left exposed to the air. Many prints may be stacked compactly in a drying rack improvised from a few, old drawing boards with wood strips between them to allow a free circulation of air.

Color Blocks

Tint Block Prints.

Almost any black-and-white linoleum print will be improved in its appeal when it is printed over a light tint of some second color. This is easily done by simply printing from a solid, flat block of either the same size of the print or a little larger to show a colored margin all around the four sides of the black-and-white picture. No cutting beyond squaring and trimming is done on this block. The tint should preferably be done in a transparent ink, or, if an oil-base ink, a good bit of mixing white should be added into a very small amount of the colored ink.

Some designs, notably landscape subjects with a sky background, may be further improved by cutting into the tint block a few judiciously designed white lines, such as the outlines of clouds, through which the white of the paper will appear in the print and so introduce a third color effect. Very interesting highlight effects may be obtained in this way, adding greatly to the liveliness and the expressiveness of the prints.

Multicolor Block Prints.

The most artistic prints of either a purely decorative or pictorial character are obtained by printing from linoleum in several colors. A separate block must be provided for the printing of each color. The superimposed impressions from these various blocks on the same sheet make the multicolor block print. A halftone rendering of a number of color prints is given in Fig. 21. The number of colors used in making these prints varies from four to twelve.

The choice of the number of colors is not only a matter of the artist's whim. Mere multiplication of colors does not, by itself, add to the value of the composition. Here again, the limitations of the medium should be kept in mind. As we simplify and conventionalize in our designing, so also should we strive for economy in colors. Color block printing cannot and should not attempt to take the place of painting, nor should the artist indulge in riotousness of color and make it the sole interest of his prints.

Analyze Your Design for Colors.

All the colors must be used in flat masses. They are like the parts of a jig-saw puzzle which, when fitted together, will make a picture. It is imperative to work out a definite color scheme for the whole print before any other work can be undertaken. Here, too, a working drawing must be made, in full color. Use crayons, water colors or colored pencils, but color every part as nearly the exact shade you want to appear on your print. Remember that each color requires the cutting of a separate block; the amount of labor involved is one more reason to keep the number of colors down to the essential ones. Whenever possible use a specific color in more than one of the areas of your drawing. Make several quick tracings of your layout and color them in various combinations of colors; then select the one that most nearly expresses the idea, the feeling, or the mood you are seeking.

Making color prints requires considerably more thought and much more thorough planning than a black-and-white composition. The beginner's first question is almost invariably: "How can I get the different printings to match up accurately on the paper?" The solution of this very real problem begins with our color analysis.

Color Register.

This matching up along all lines where two or more colors meet is called "register." A well-registered print is one in which the various colors neither

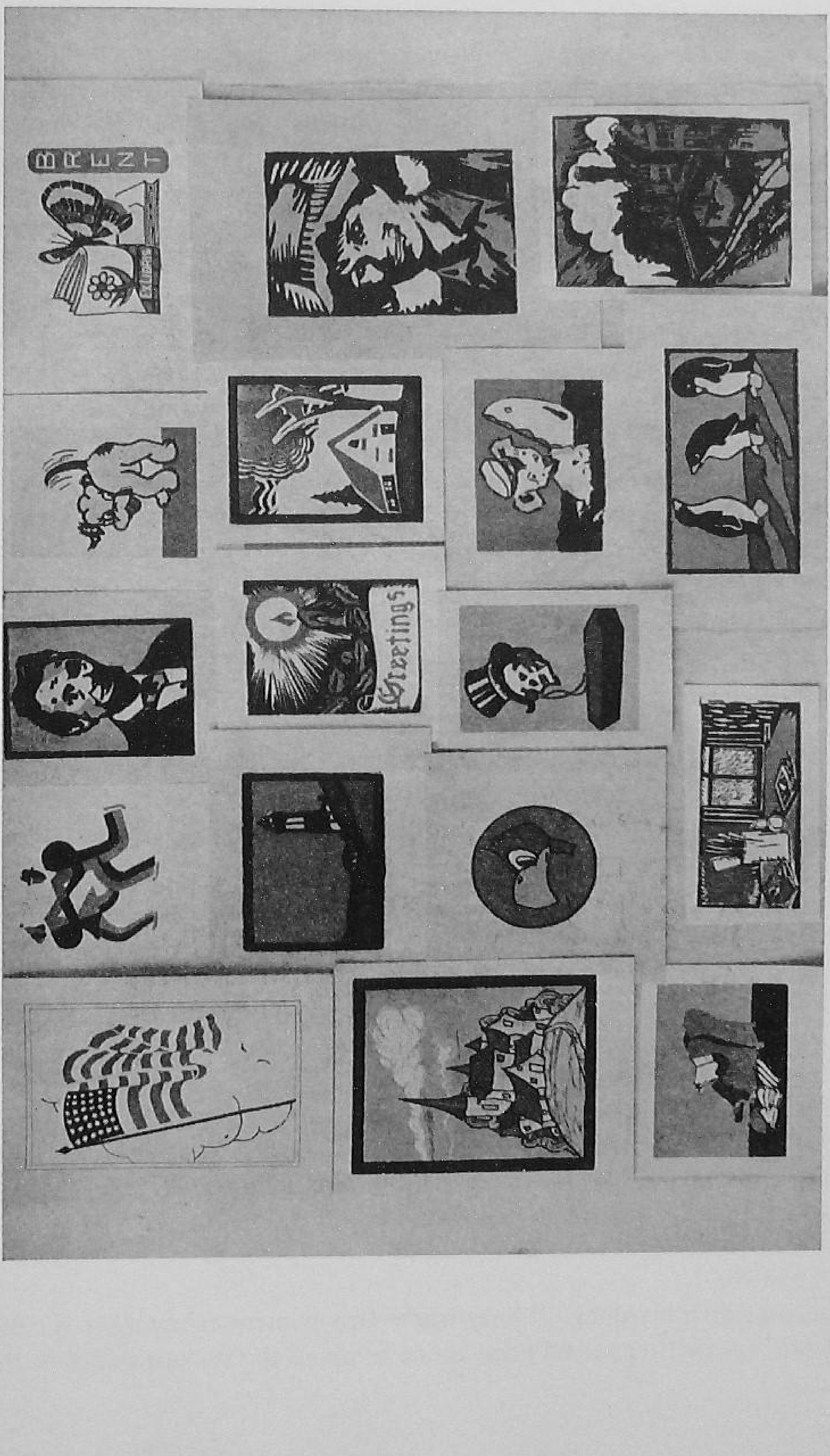


Fig. 21. Examples of color prints.

overlap nor fail to meet, leaving white lines or dots through which the white of the paper is visible. Such breaks, no matter how small, will mar a print; they have a peculiar power of distracting all the attention of the onlooker to even a slight discrepancy, thus spoiling the effect of the whole print far beyond the extent of their mechanical importance. Good register, however, is not quite as difficult to achieve as it might appear at first sight, provided the problem is really understood and a well-planned procedure is adopted and consistently followed.

The problem consists in maintaining the exact space relationship in which the various color areas are arranged in the drawing. Suppose we trim this drawing in all four directions to a perfect rectangle along the extremities of the design. Each separate color area will be in a definite space relationship to the trimmed edges of the paper. Suppose further that we trim as many linoleum blocks as we have colors to exactly the same rectangle and trace and cut on each one of the colors. The relief areas on the blocks will be in the same relationship to the outside edges of the blocks as the color areas were on the drawing. These outside edges will be our reference lines. If, during printing, we can maintain a similar constant relationship between our reference lines—that is, the physical outlines of our several blocks and the edges of the sheet being printed—we will have perfect register on our prints, discounting discrepancies which result from faulty cutting.

When you have once disciplined your thinking to a comprehension of these fundamental principles, color block printing will appear much less complicated an undertaking. In their practical application we can even simplify them: indeed, two reference lines will be quite sufficient, provided we choose two that meet at right angles. The best practice is to make the top and the left side of your blocks your reference lines. This allows for more comfortable feeding of the sheets in printing.

Tracing Your Colors.

With these reference lines in mind let us return to your drawing. You must make a tracing of it in the same manner as you did for the one-color print, but here you must also delineate the outlines of each separate color area in a very fine, thin line. Turn your tracing over to reverse it, and lay out, at the left side and top, your two reference lines. Place them at not more than ⅛" from the design, and be sure to use a reliable square to draw them in. Use a fine pen and ink, a ruling pen preferably if you

have one. Make sure that they meet at exactly 90 degrees. All the transfers for the various color blocks are made from this one tracing.

Transferring the Color Areas.

Before transferring, you have decided as to whether you shall print your blocks in a platen press or by any of the hand devices you may have used for your one-color prints. The platen press requires type-high material whereas all of the other devices allow you to cut your blocks in flat, unmounted linoleum.

Your mounted blocks are presumably squared accurately. So you have to look out only to fit the right angle of your reference lines perfectly over the corner of your block. Fold the top of your tracing over the edge of the block and attach it to the side with either thumbtacks or Scotch cellulose tape. Insert a sheet of carbon paper and proceed to trace in the first color with a sharp, hard pencil. Painstaking care is needed for this operation. It is the price you have to pay for good results all along the craft. Repeat the same procedure for all the other colors on the respective blocks.

When working with unmounted linoleum make your transfers in the same way with one exception: do not attempt to fit the right angles of the reference lines and the pieces of linoleum. Fasten your tracing to the linoleum by folding the margins under the back of the material and trace the reference lines in with each separate color. Use a ruler and make only a very thin sharp line. When all your transfers are done, trim the various blocks to a perfect right angle along the reference lines, using a steel ruler and a well-sharpened knife. Cut all the way through the linoleum and keep your knife blade perfectly vertical. A slanted edge, especially if the slant is away from the linoleum face, will not represent your true reference lines. The accuracy with which you transfer and trim the reference lines determines to a large extent the success or failure of your color registering.

Cutting Your Color Blocks.

The engraving of your color blocks is done in exactly the same way as if they were so many single-color cuts. In your anxiety to cut very close, be sure you do not encroach into the traced lines when outlining with the veiner. Always keep the cutting edge of your tool just outside the line on which you are working. If this should, here and there, result in a very small overlapping of two adjacent colors, the slight inaccuracy would not

be quite as detrimental to your print as the showing of a white separation. If necessary it could be remedied quite readily by further trimming of the lines.

Printing the Color Blocks.

If a platen press is to be used for the printing, all the blocks must be exactly type-high. As we used the reference lines before for separating the colors, they will now serve for reassembling the colors again. This is done in the locking-up in the chase. Lock the first block, using a given amount of either wood or metal furniture between the inside of the chase frame and the top and left side of the block. Note the amount of furniture used in each of these two directions, and use exactly the same amount either way for each of the successive blocks. See Fig. 25. The right angle that these two amounts of furniture form in the chase corresponds to the right angle on our blocks. If we maintain it constant as we did the former, our register on the tympan of the press will be so close that in most cases we shall not even have to touch the gauge pins when changing from one color to the next. The press, of course, must be inked with the colored inks and thoroughly washed at the end of each run. Even a speck of ink left from a previous run, either on the inking disk or on the rollers, may adulterate the color of the new ink to be run. This holds especially true if a light color is made to follow a darker one. In this case a double wash may be required if the tone of the lighter color is to be held true.

All the sheets that make up the planned edition must be printed in the first, then the second, and subsequent colors, so that the first completely

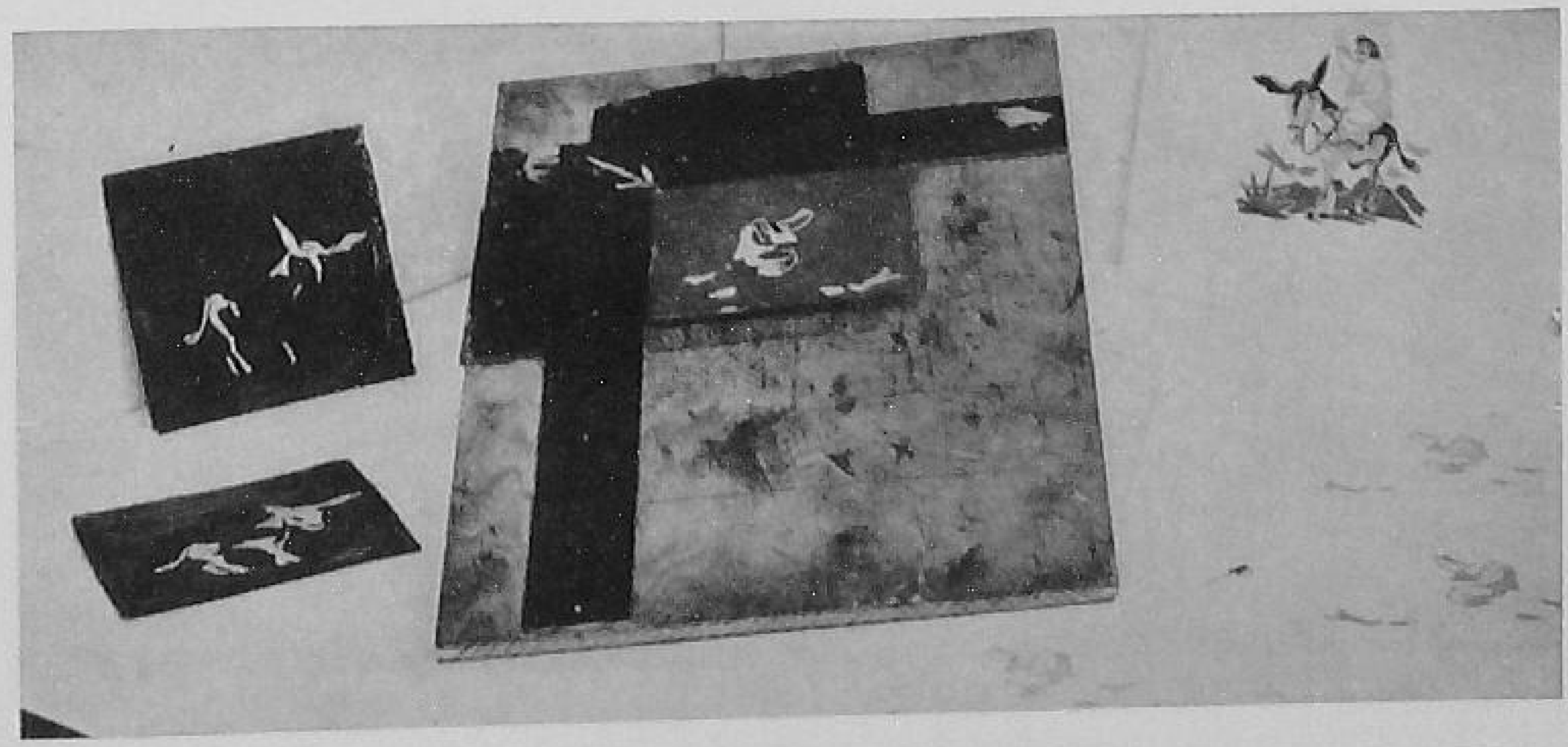


FIG. 22. Color registering jig.

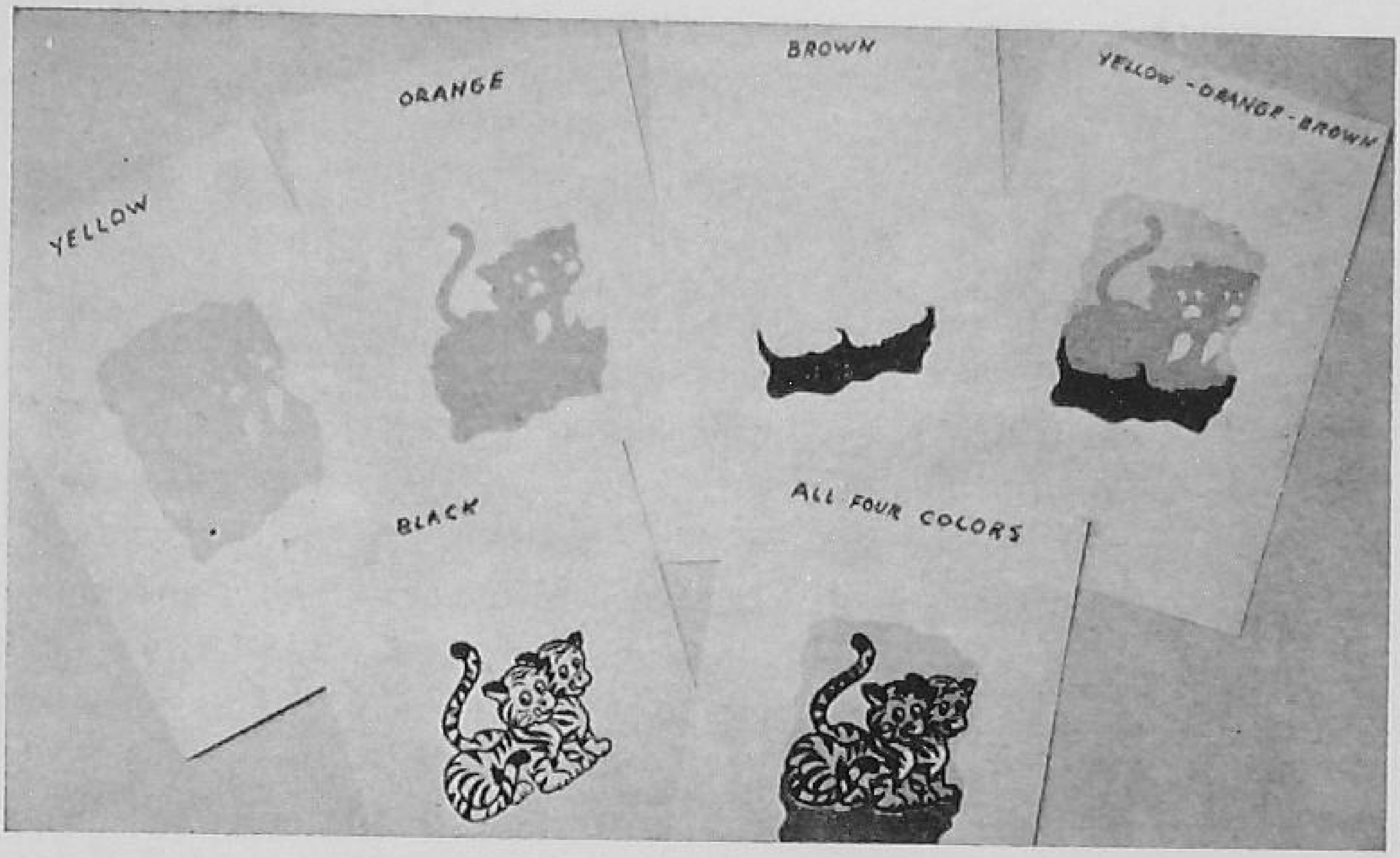


FIG. 23. A four-color sequence. The white of the paper is used to get a five-color effect.

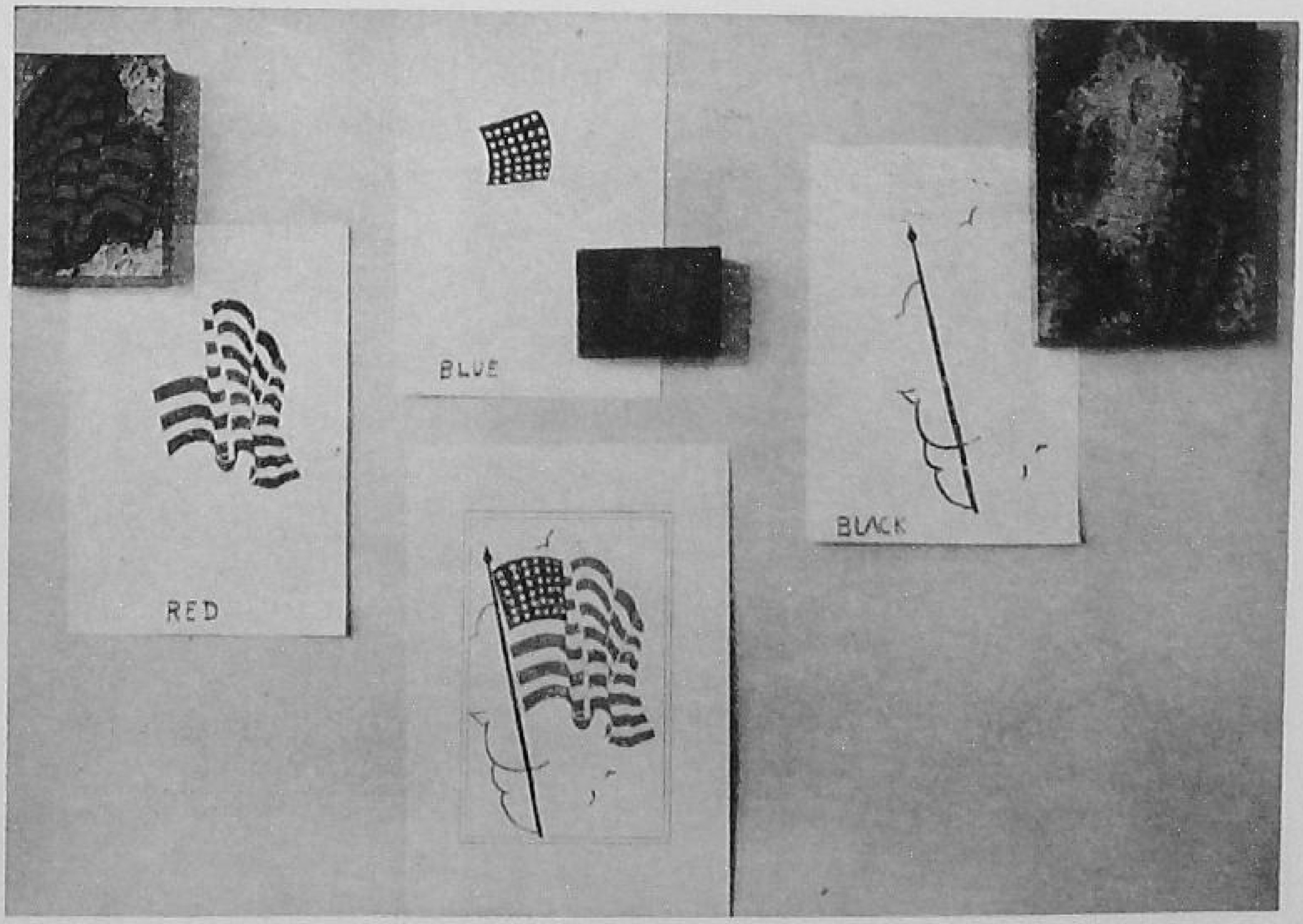


FIG. 24. Blocks, proofs and finished print of three-color design. The border was printed with metal rule.

finished print is obtained only when the last of the colors is being put on. This sometimes taxes the artist's patience to the utmost, especially if the various printings have to be spread over several days.

When the printing is being done with any of the hand-printing devices, a full-color print may be made immediately. An ink slab and a brayer for each color must be provided. It is best to arrange the sequence of slabs and brayers on a large table, in the order of printing you have decided upon, with the respective blocks resting in front of the slabs. Ink the first

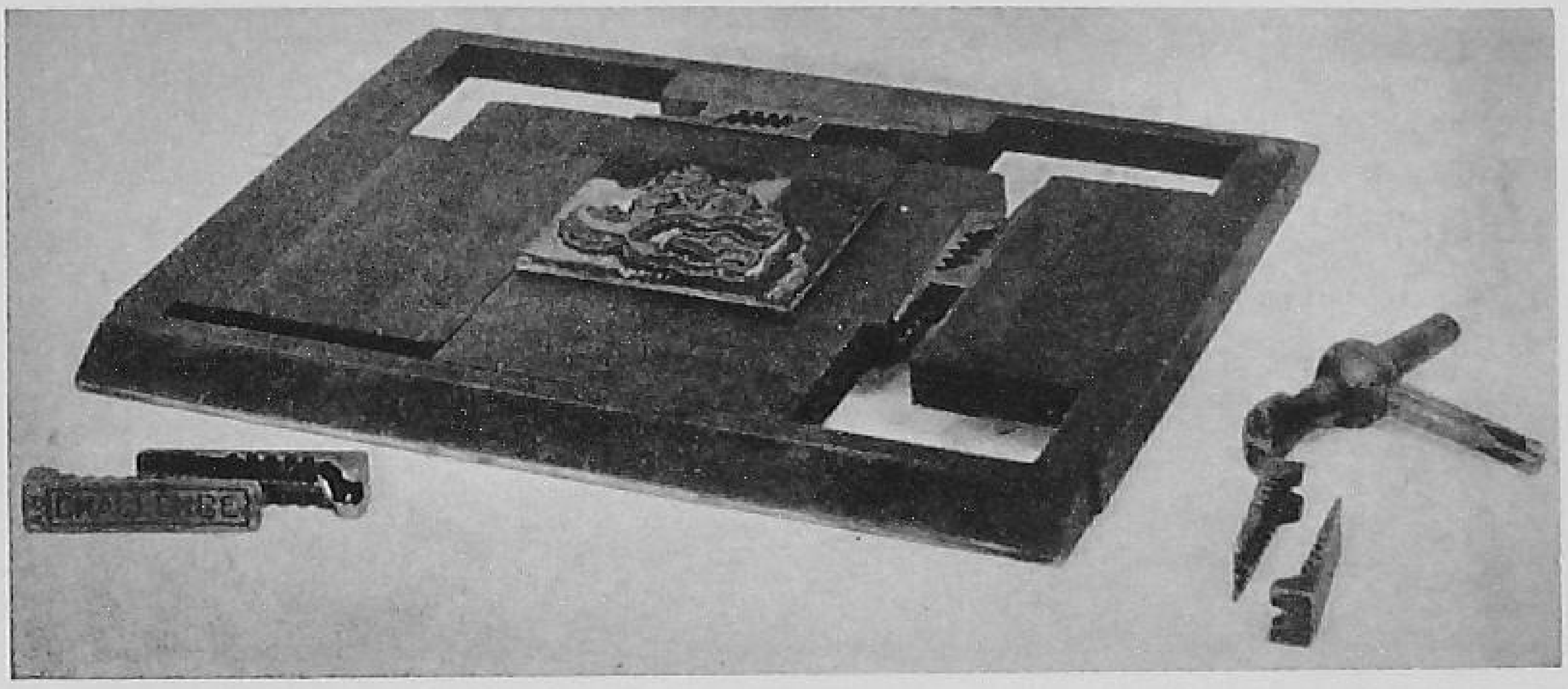


FIG. 25. Block locked in chase for printing on a platen press.

cut, place it in the right angle notch of the printing jig, fix the marginal stops for the sheet on the top and side of the jig (see Fig. 22) and print, applying pressure in the way planned. Lift the printed sheet off, replace the block in the jig with the one inked for the next color, and repeat as often as necessary until your first print is completely finished.

Great care must be exercised in handling the ink brayers and the inked blocks. It is all too easy to get ink all over your hands, clothing, and other tools and working materials. However, this need not happen. Careful planning and methodical working, once a plan is evolved, may somewhat strain the impulse to dash ahead, but they are indispensable ingredients of true craftsmanship.

Colored inks of many shades are available commercially. If you should want to make your own, you may use drawing ink and flour paste as described on page 22, substituting colored drawing inks for the Chinese black. In the absence of liquid, colored drawing inks, colors ground in

powder form, such as those sold in paint stores, may be mixed in a little water. Here again the face of the linoleum must be perfectly free from any oily film that would prevent the water paint from adhering to it.

There is no hard-and-fast rule as to the order in which colors should be printed. It is, however, almost always advisable to print the lighter colors first, especially when opaque inks are being used. Transparent inks combine to make different tones when two colors are superimposed one on another. The results often vary, if the order of printing the original two colors is reversed.

It is hardly necessary to repeat that all the ink slabs, ink knives, brayers and all other tools must be thoroughly washed at the end of each printing period. Color print making is an exacting craft, demanding constant attention to many details, and a good amount of downright labor. But then, that is the case with all art and craft work.

Chapter II

WOOD-ENGRAVING

The Place of Wood-engraving in the Art of Today

Development.

Wood-engraving may be called both a very old and a very recent art or craft. In the preceding section of this book we have seen that the very first pictorial prints ever made were taken from carved wood blocks. And if we study the history of art we encounter wood block printing at every stage from the middle ages onward. However, it is also a new art in the sense that in the last half century it has undergone a radical evolution, in outlook, in aim and in technique. When, in the latter half of the last century, the photo-mechanical processes displaced wood-engraving as the pictorial medium of illustrated papers and books, the craft at first declined and then, with surprising vigor and vitality, staged a revival, not as a commercial means of reproduction, but as a truly autonomous creative art. It had found itself technically at last and matured into what it is today with a promise of what it will be tomorrow: a new, self-contained medium of expression for the creative artist.

The Revival.

The influence that culminated in this reformation can be traced back to the early part of the nineteenth century when the Englishman Sir Thomas Bewick first began to work in the so-called white line. He was the first to have conceived his subjects in terms of white on black, that is, of white cut into the solid black of the untouched block. Before him, wood-engraving was done on the same style as, and probably only as, a cheaper and easier substitute for copper- and steel-engraving. The picture appeared in black lines on a white background. The artist drew the picture on the block, and professional block cutters carved out all but the lines drawn. However, the pressure for speed and accurate imitation was so great that Bewick's revolutionary approach was left unexploited until a

group of English and American artists in the early part of our century re-evaluated and restudied his blocks and began to work in the new manner with the result that they arrived at an entirely new, maturer conception.

Wood-engraving today no longer aims at imitation of painting or drawing. It would indeed be a tedious and laborious substitute for either. Truer and immensely cheaper reproductions can be readily made with the aid of the camera. The wood-engraver of this day has become an artist-craftsman in the true sense of that name: he has an idea, a message or a feeling to express, and he does so in a medium that conveys his message better than any other. Further, he does all the work himself, with his own mind and hands.

Limitations and Possibilities.

As a technique wood-engraving is a relief process similar to linoleum block cutting, only much more refined, more expressive and also more difficult of execution. The material is harder, the labor of cutting is slower, demanding considerably more time, but the results too are more beautiful and exquisite. It is an exacting hobby for the amateur artist; but, if art is art's own reward, wood-engraving is also one of the hobbies richest in the reward of inner satisfaction.

Unlike with linoleum, the artist can express on the wood block almost any shade of light, from dazzling highlight to solid black. Texture and color can be translated into tones by the arrangement of lines. Nevertheless here, too, the designer planning his picture must avoid any attempt at portraiture of the type obtained with the camera. Details must be simplified and shapes symbolized. The action of the graver and the scorper on the wood demands this frugality of detail. No unessentials should enter into the composition. This simplification results in a directness of impression in the print that is exactly the distinguishng mark that makes a wood-engraving what it is. If the same effect could be obtained with pen and ink or any other process, there would be no justification for the expenditure of time and effort in making a block.

Materials

End-grain Blocks.

Wood-engraving is done on the planed and polished end-grain surface of hardwood blocks. The end grain is chosen because it is the only surface

on which the gravers will make a consistently even incision. Cutting with the graver across the grain of a plankwise board will tear the fibers and leave a ragged, fuzzy edge, whereas on the end grain every line is sharp and neat, as if cut in metal. Fig. 26 shows an end-grain block in comparison with a piece of wood sawed the ordinary or plankwise way.

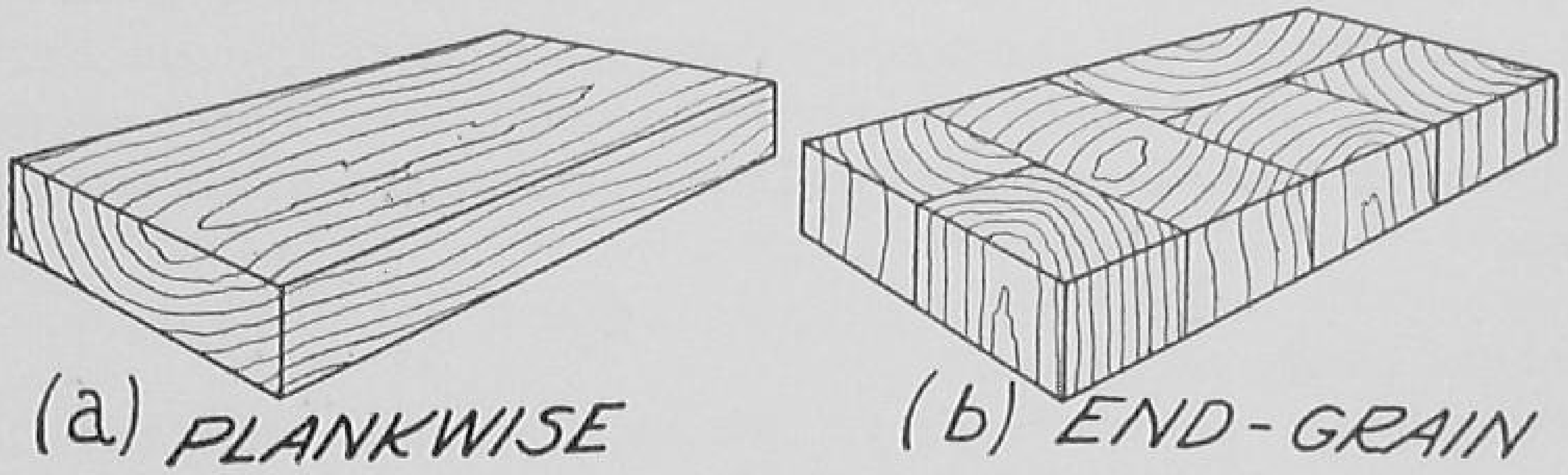


FIG. 26.

Boxwood.

Boxwood is the finest grained wood obtainable and, for this reason, the first choice of the wood-engraver. The closeness of its texture approaches that of ivory, thus allowing for the successful carving of the very finest lines. Imported boxwood comes from either Russia or Turkey, the latter's product being reputed the best. Native American boxwood is less expensive and quite satisfactory for any but the most exacting work. No amateur is ever likely to exhaust its possibilities to the point where he shall have to hunt up imported wood.

Boxwood trees take a very long time to grow to a thickness sizable enough to allow their being cut into end-grain slices. All but the very smallest blocks are built up in sections. The slices cut from the logs are rigidly inspected, and only the best are trimmed into rectangular blocks which are later glued together so closely that no joint will appear as a crack in the surface of the slabs, although the coloring and grain formation of the small sections are generally distinctly visible. This joining is a remarkable achievement of the woodworker's art. It is very seldom indeed that a block, if not exposed to moisture, will ever part at a joint. Museums exhibit blocks several hundred years old and with no appearance of any cracked joints.

Maple and Cherry.

Other woods may be successfully used, such as maple, pear, and sometimes cherry. Some grades of maple are almost as hard and close-grained

as boxwood, and, being considerably cheaper, will make excellent blocks for practice work. Pear and cherry wood are very much softer. They are not readily found stocked in prepared end-grain blocks and, unless there is a specific reason for selecting them, it is better to avoid them. When it is decided to use them, the engraver must make doubly sure of the sharpness of his tools. The softer the wood, the sharper the tools need be for good cutting. This is not to be construed to mean that the harder woods can be cut with dull tools. On them a dull tool will simply not cut; on the softer woods the same dull tool will tear the fibers instead of slicing them.

Sizes and Comparative Costs.

Blocks are to be had in many stock sizes or cut to order from the built-up slabs, at prices ranging from about two cents per square inch for domestic pear to as much as 25 cents for the same size of imported boxwood, if the very best grade is wanted. American boxwood is a little below the average of these two extremes, and maple sells for still considerably less. If your local art dealer does not carry any wood blocks in stock, you may buy them by mail from various supply houses.

Storing the Blocks.

Store all your blocks in a dry place, away from stoves or radiators and the direct action of the sun. Stand them on edge rather than laying them flat, especially if they are of a considerable size, to avoid warping. Warped blocks can sometimes be straightened out by moistening the face or the back, according to the direction of the warping; but, of course, it is better to prevent all warping in the first place. When standing the blocks together, place the polished and slightly shellacked faces of two successive blocks together. The underside is generally rough-sawed and might cause bad scratching.

Preparation of the Blocks.

The blocks may be used for cutting just as they are received from the dealer. However, you can improve them somewhat by first soaking them a short while in pure linseed oil. You will find that you can cut a finer line, and that all the lines will be considerably smoother. However, this soaking must be done well ahead of the cutting, as the oil must have completely dried before using the block. If it has not entirely dried, the excess oil will ooze out of the pores of the wood, both in cutting and in printing, and so

prove a source of annoyance rather than help. The thin shellac coating that the manufacturer has put on the face of the block must, of course, be removed with a little alcohol before soaking the block in oil. Not all blocks come shellacked but some do; remove this coating, even though the block is not going to be soaked. The shellac is put on merely to prevent the wood from absorbing moisture from the damp atmosphere in humid weather.

Wood-engraving Tools

Gravers.

The gravers or burins used in wood-engraving are tools entirely different from the ones we have used in linoleum cutting, although they may, at first sight, seem alike. Unlike the linoleum cutting tools, they are not hollowed or shaped to lift a chip; they are of a solid body with a beveled point, of the type used for copper- and steel-engraving.

A great variety of shapes and points has been developed by individual artists, but basically they can all be reduced to two classes: according to the shape of the incision they make on the wood, or, to say it differently, according to the white mark they cut into the solid black of the printed block. From this point of view we have: (1) those used to make fine outlines, thin lines, and close tint-lines. These are all gravers or burins, comprising the round-edge gravers, the lozenge tools, the spitsticker, the bullsticker, and the tint tools, all shown in Fig. 27. (2) Those used for scooping out larger areas or for cutting wider lines are called scorpers, and may be had with either a flat or a convex cutting edge. These are shown in the lower part of the same illustration. On the gravers the bevel of the cutting edge should make an angle of 45 degrees with the base line of the tool itself. On the scorpers this angle is slightly more acute, about 38 degrees. See Fig. 27.

All these tools should be solidly mounted in regular graver handles of the type shown in Fig. 28. Approximately the lower third of the handle is cut away to allow the tool to glide over a large block, at a very small angle, almost horizontally. This angle determines the depth to which the tool point buries into the wood. If it is not kept down to an absolute minimum, continuous cutting is impossible, as the tool will insinuate itself deeper and deeper into the wood, making an ever-widening line. So the flat part of the handle must at all times be barely above the cutting surface of the wood. This flat of the handle also prevents tools from rolling off the table when they are laid down.

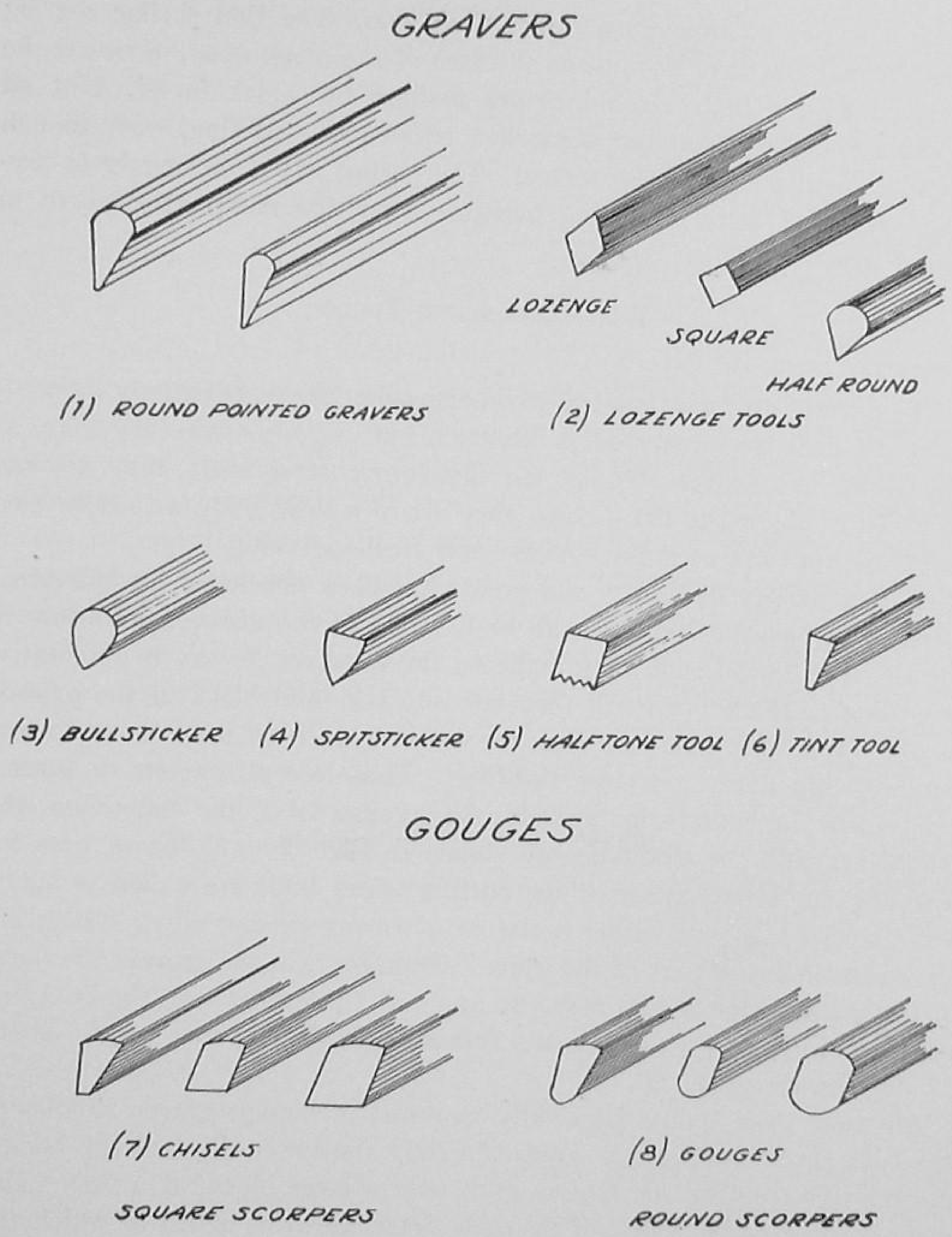


Fig. 27.

Selection of Tools.

Do not waste your money in buying cheap and questionable tools. They will never hold a sharp edge and will only be a source of annoyance and disappointment. The number of tools a beginner should buy is, of course,

dependent upon the size of his pocketbook. For most of us this will be limited, and we must make a wise choice the first time. It is quite sufficient, for a start, to acquire perhaps three gravers of different sizes, a half-round lozenge tool, and a small and a large scorper. These are the fundamental tools. Others may be added to your kit as your increased interest and your own style of working will indicate them as useful or desirable.

Sharpening of Tools.

Good work is possible only with sharp tools. A good oilstone and a slipstone are "musts" in any tool kit, and they should always be close at hand when working. Sharpening the tools is not a difficult operation if you will go at it in a systematic way. First of all study the shape of your sharpened tool when you first get it from the manufacturer. Note that the bevel is perfectly flat; that the corners of the beveled surface are sharp and neat. When you re-sharpen the tools, you should reproduce this condition with full precision. Never alter the cutting point by rubbing the base line of the tool over the oilstone. Hold the bevel flat on the stone and move it back and forth on the stone, in oil, with a steady, even motion. Rocking your hand will result in rounded edges. If a hairline burr develops on the cutting edge in sharpening, take it off delicately with the slipstone.

After extended usage, your oilstone may become filled with dried oil and microscopic metal particles. You can wash them both away with benzine or gasoline; this cleaning will restore the bite of the stone.

Using the Wood-engraving Tools

How to Hold the Tools.

New tools generally come long enough to fit the largest hand and they may have to be shortened to the size of your own. For most people a burin is most manageable when it measures from $4\frac{1}{2}''$ to $4\frac{3}{4}''$ from the cutting tip to the end of the handle. For cutting on the block the round end or heel of the handle is firmly fitted into the palm of the right hand, resting towards the base of the little finger. The blade of the tool lies along the inner cushion of the thumb, while the other three fingers push the blade against the thumb. The tips of these three fingers must not extend below the lower edge or base line of the tool itself, thus allowing the tool's free passage over the entire block at the very acute cutting angle required. Remember that the tool must glide almost horizontally over the

block. Both elbows rest comfortably on the table or bench, and while the left hand guides and turns the block, the right one, resting lightly on the wood surface, pushes the tool with the thumb and the heel of the hand. The thumb acts as a sort of steady pivotal point. Pushed forward by the contraction of the hand and the tips of the three other fingers, the tool slides between the thumb and the forefinger to the full extent of the stroke. Without lifting the tool, the thumb and forefinger travel to their full extension again, and a new section of the same line is cut in the same

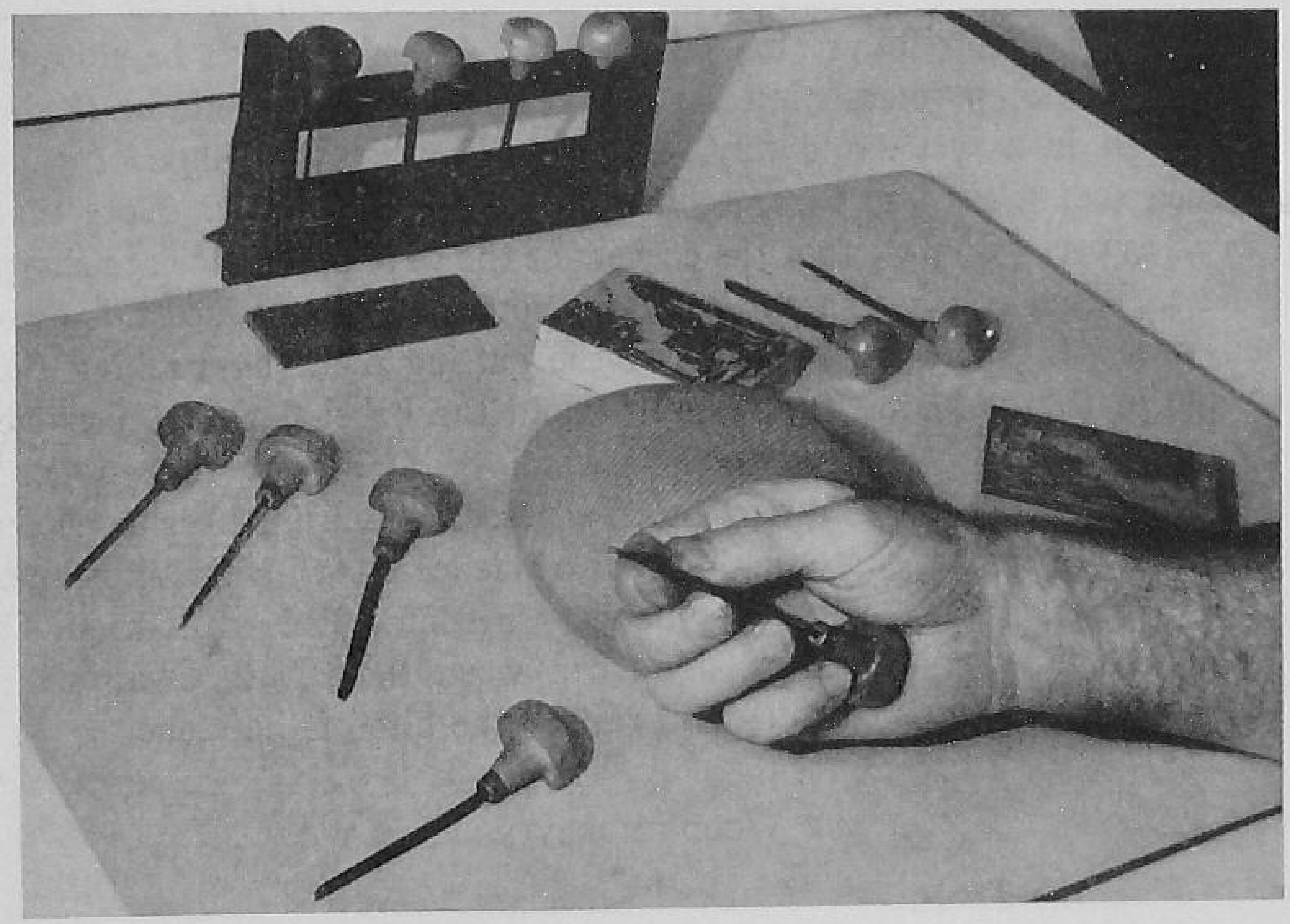


Fig. 28. Graver handles.

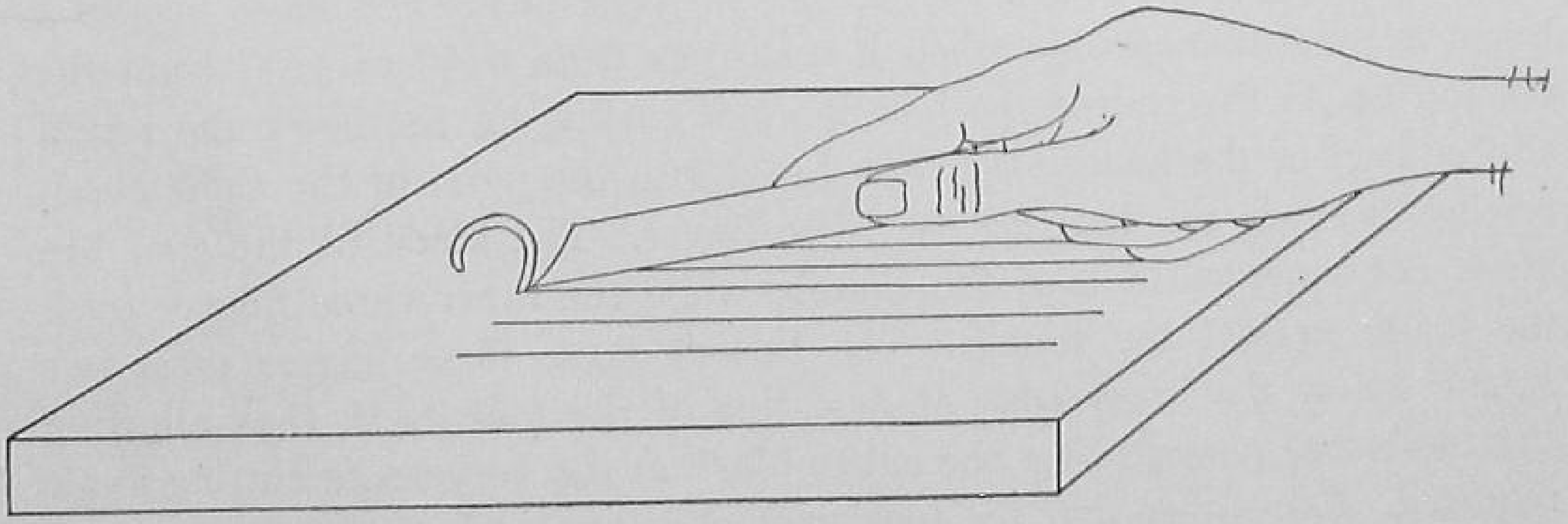


Fig. 29. Proper way of holding tools.

fashion. Never push from the arm or the wrist. You could not control your tool sufficiently and would almost certainly overrun your mark. Wood-engraving is a *slow* process. Fig. 28 and Fig. 29 show the proper way of holding tools. See also Fig. 37, page 53.

Starting and Ending a Stroke.

To start a line, pierce the wood surface with the tool, holding the latter at about a 30-degree angle from the horizontal. Immediately lower the

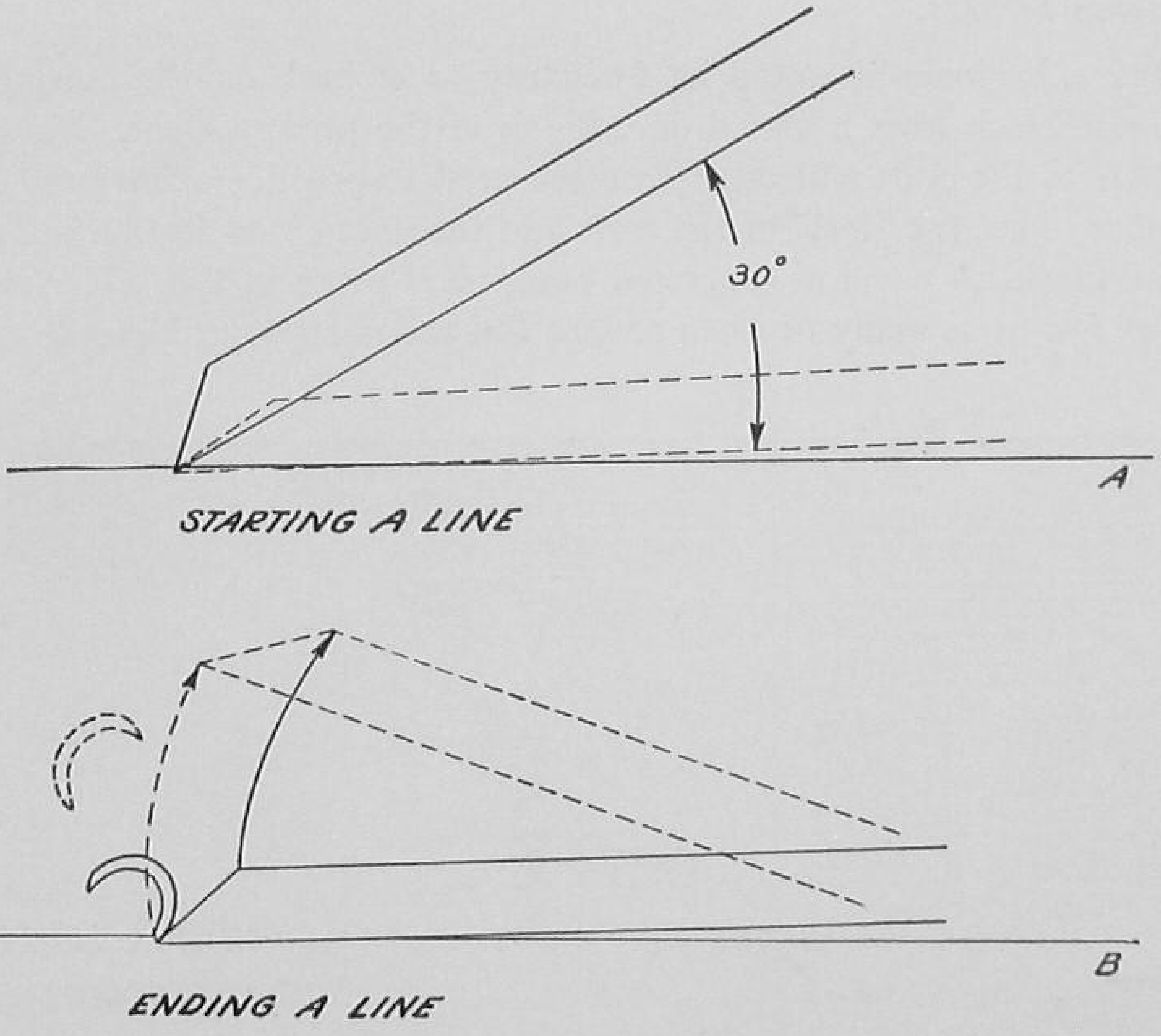


FIG. 30. Starting and ending a stroke.

tool so that it is almost level with the block as shown in Fig. 30 and explained above, and push by contracting the hand. At the finish of a line, end up with a sharp flip, severing the curled wood thread cleanly. See Fig. 30. If you hold your tool at too high an angle it will bury itself much deeper into the wood, widening the line unequally and sometimes breaking the tip of the tool in the wood.

All the above descriptions are given in the nature of recommendations

rather than as rules. No two artists work exactly alike. Your grip on the tool must suit your own hand, and above all it must allow you to work prolongedly without creating cramps in your fingers. As you become more fully acquainted with each particular tool you will acquire a style of your own. Remember that there are many ways of holding a pen and, as a result, there are as many styles of handwriting. But as long as a given handwriting is legible and clear we do not quarrel with the way the writer holds his pen or pencil.

Practice Strokes.

For a beginner it would be foolhardy to embark on the cutting of a full-size block from a verbal description of the process alone. Most newcomers to the craft will experience the need to practice a few preliminary strokes to get the "feel" of the tools and their action on the surface of the wood block. A panel of suggested exercises is given in Fig. 31. You may do as few or as many of them as you feel are necessary. Naturally, how-

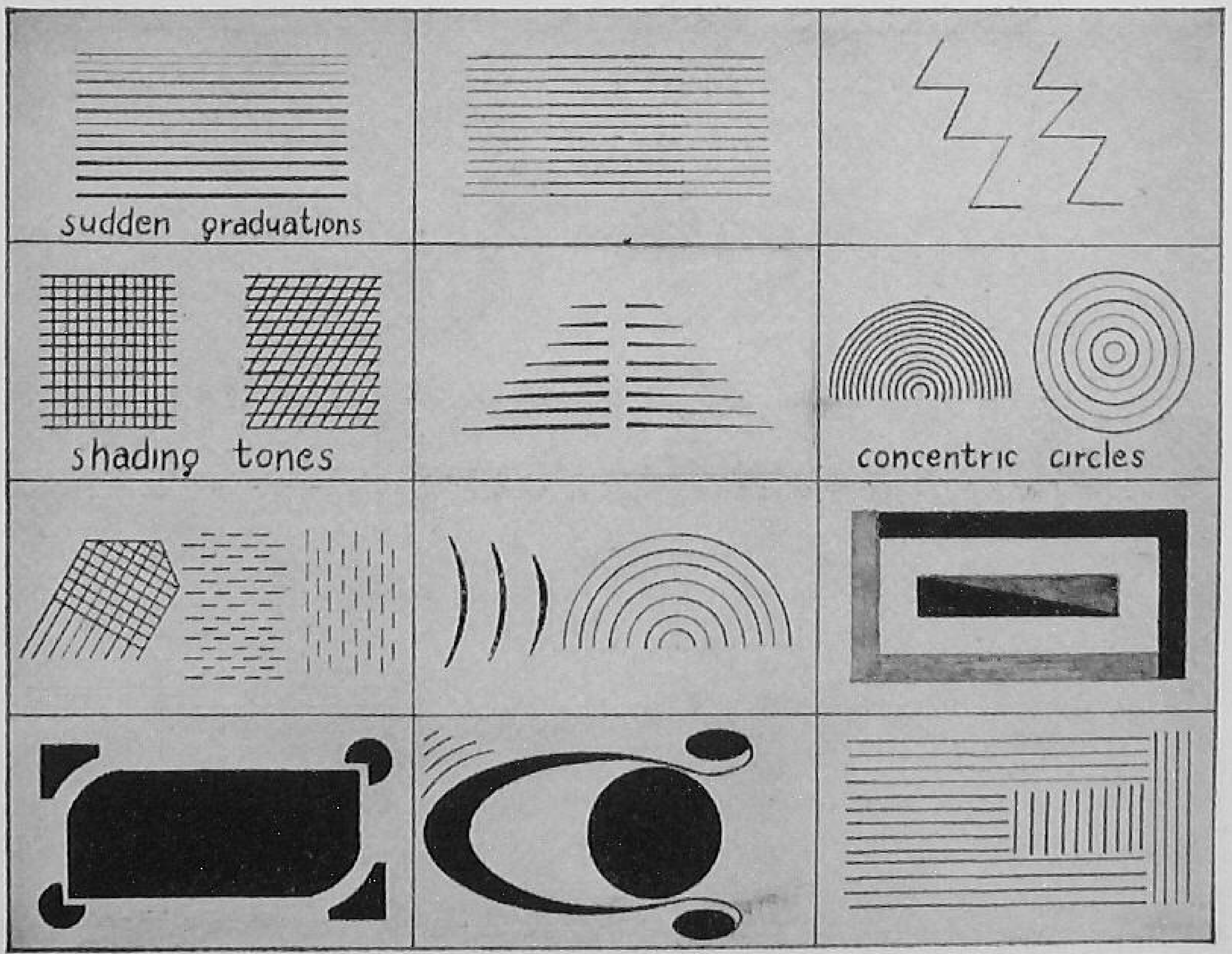


FIG. 31. Practice strokes.

ever, the more of them you practice, the freer and more confidently you may approach your first block.

Remove the thin shellac coating from a small block of maple or box, and rub a very small quantity of black printer's ink into the wood. Wipe off any surplus with a rag. If you have no printer's ink, use India drawing ink or anything else that will give a solid black surface. Blackening the surface of the wood will allow you to see directly the action and the result of all your strokes with the tools, as the white wood will appear like a traced line in the solid black field, much like a white chalk mark stands out on a blackboard.

As a general guide in practicing these exercises, bear in mind the individual use of each type of tool. For exercises 1 to 6, of even parellel or concentric lines, use the round-pointed gravers of the various sizes; for exercises 7, 8, and 9, that is, for lines of varying thickness, work with the lozenge tool; in removing the broader areas of exercises 10 and 11, get acquainted with your scorpers. When starting a series of lines at right angles as in exercise 12, lay a thin, strong card—a business card will do—over the edge of the lines already cut so as not to bruise this edge with the body of the graver. See Fig. 31a below.

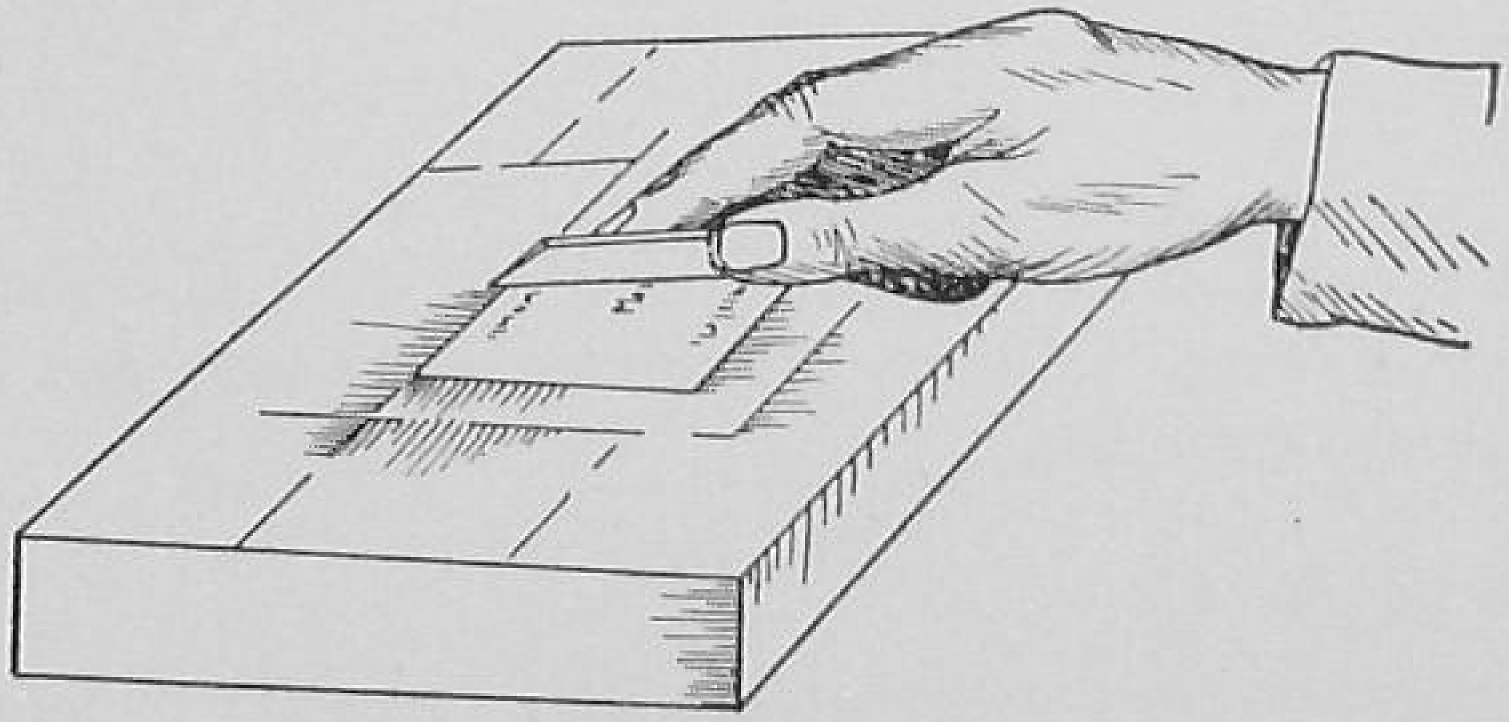


FIG. 31a. Using a card to protect previous cuts against heel of the tool.

PREPARING FOR A WOOD-ENGRAVING

Make a Drawing.

When you have attained sufficient dexterity in the manipulation of the tools to undertake the engraving of a block, you should first make a preliminary drawing of your subject on paper. See Fig. 32. As your experience broadens, you may come to the point where you can engrave your composition free-hand on the block directly. However, until then lay out

your work in detail on paper or on the block itself if you want to avoid disappointment. Bear in mind that certain subjects will require reversing of the drawing. The necessity for simplification has already been pointed out as one of the limitations of the medium of wood-engraving. It will be

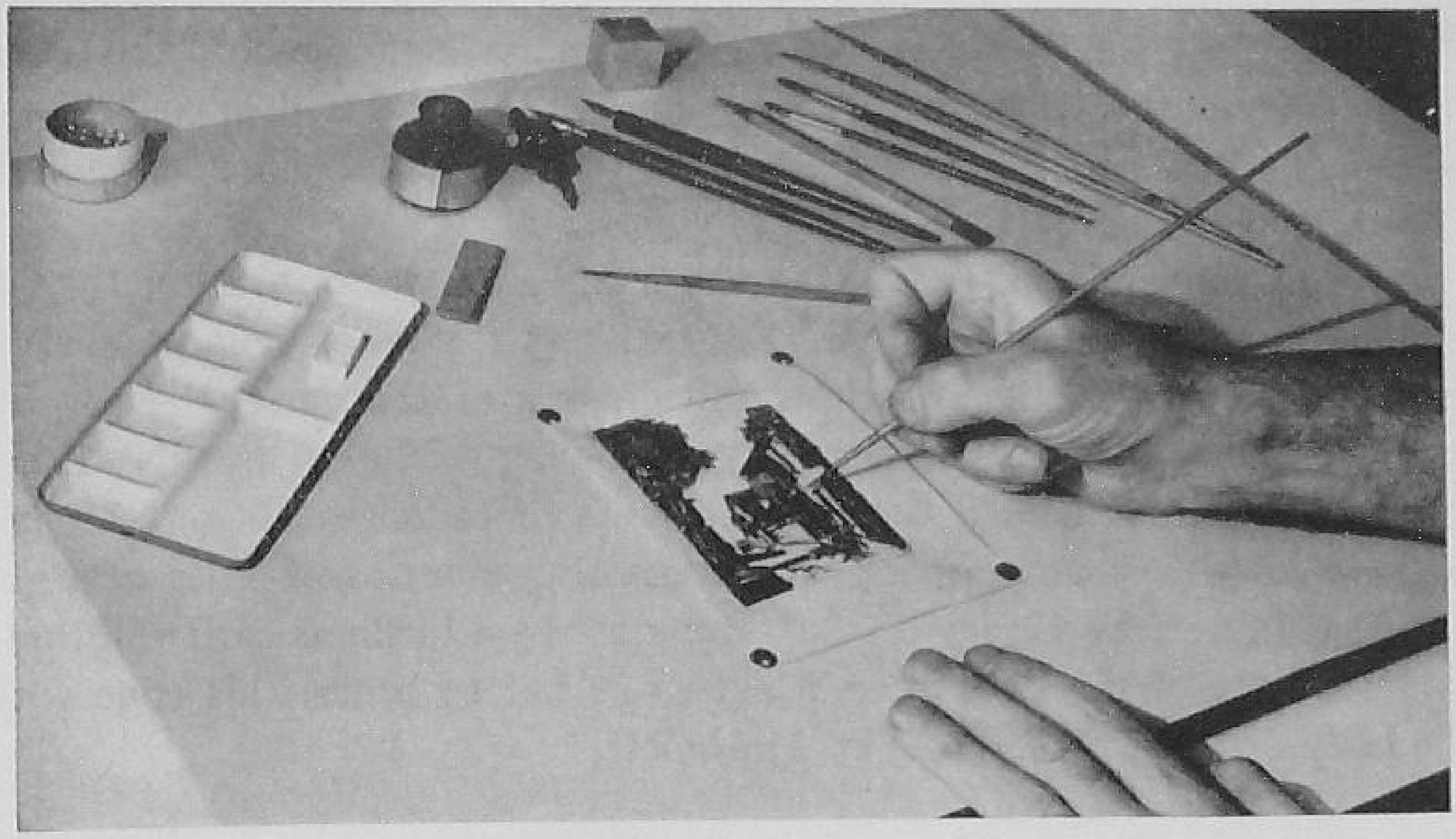


FIG. 32. Making a preliminary drawing.

much more a question as to what to leave out than how much you can get into your drawing. Visualize the effect of your idea, and learn to cut ruthlessly all non-essentials.

Drawing on the Block.

The direct method of drawing on the block is always preferable. It will save much of the freshness of your designing that is often lost in successive transfers. To make your drawing more clearly visible you may coat your block with a little zinc oxide rubbed into the wood. A tiny bit of the white of an egg mixed with the white zinc will make the latter dry much faster and leave an excellent drawing surface for either pencil or pen and ink.

Mark the outlines of all tone values with a fine pencil line. Then ink in the darkest lines and areas with solid black India ink, using either a pen or a brush. See Fig. 33. For the successive lighter tones dilute the ink proportionately. When all the tonal values are inked in, your block will look like a wash drawing in black and white. Fine, white lines can

be drawn in with Chinese white or white drawing ink which can be obtained in any art store.

If your drawing work on the block is to be extensive, it may be a good investment of time and comfort to construct a hand rest. It is merely a piece of board of approximately the same thickness as the block, with a rectangular notch cut out from the upper left hand corner. It will bring the working hand to the level of the block for more comfortable and freer action.

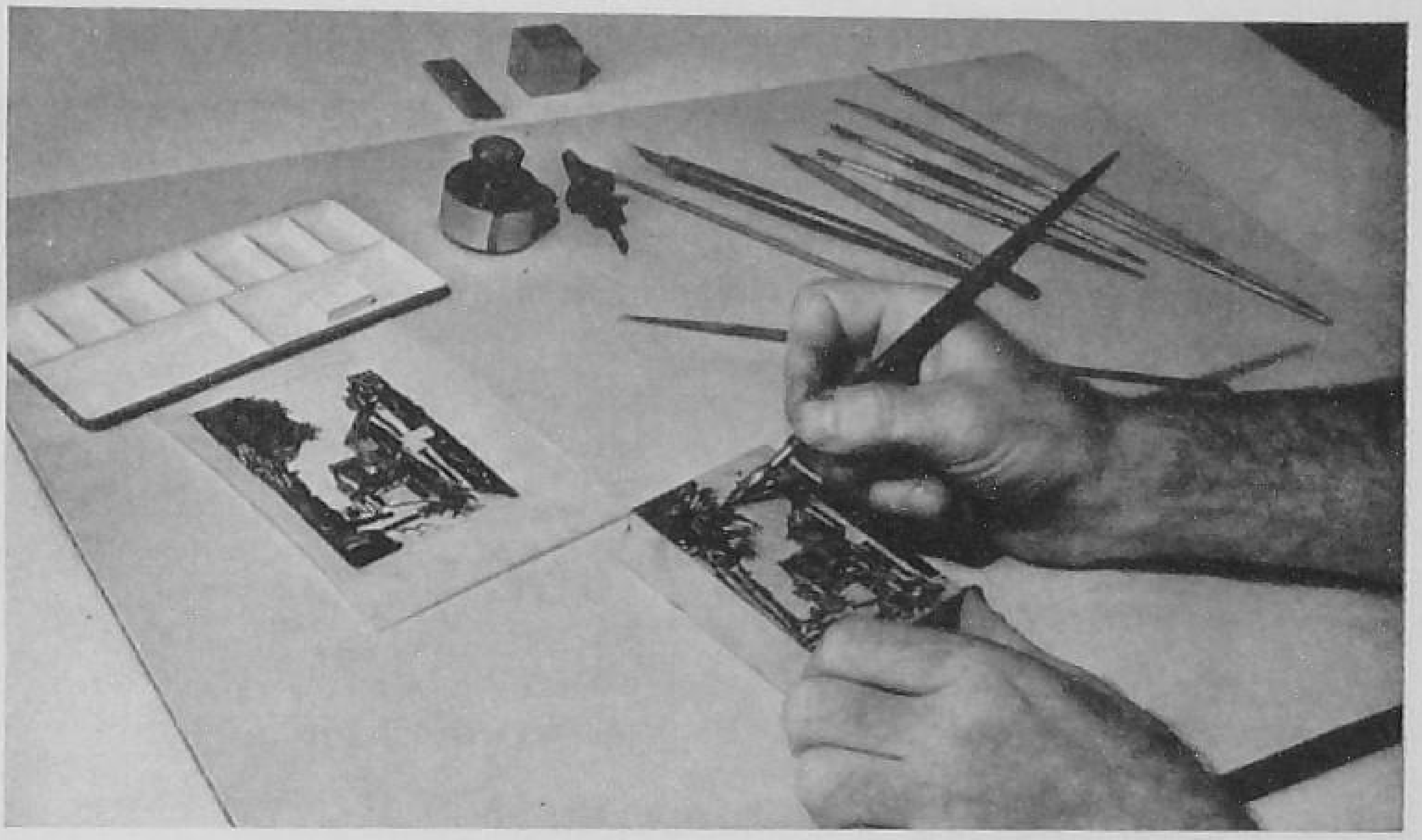


FIG. 33. Inking in darkest lines and areas.

Drawing on Paper and Transferring.

Whenever your design needs to be reversed for reasons of veracity of rendering or because of lettering in the design, you can make your complete wash drawing on ordinary bond paper and transfer it to the whitened block by the ammonia transfer method described in linoleum work on page 12. See Fig. 35. However, do not make your wash drawing on waterproof tracing paper or on highly sized paper. These are impermeable, and the ammonia cannot penetrate them to reach and release the drawing ink. Also make sure the ink you are using is not of the waterproof variety. Your design should now be clearly visible on the block. Where necessary, touch it up with black or white ink.

You may also make your transfer in pencil. Prepare your drawing in soft lead pencil on smooth paper and indicate the tone outlines clearly. Prepare your block as previously described with the zinc oxide. When fully dried, rub the whitened surface well with a very thin coat of ordinary jellied laundry soap. Do not lather the soap. Just leave the cake wet for a while and pass the palm of your hand over it. Turn your pencil drawing face down on this soap film and apply pressure. The caustic action of the soap will release enough of the graphite particles to make quite a clear transfer. Your design will now be in reverse. Make your wash drawing from its outlines as in the direct drawing method.

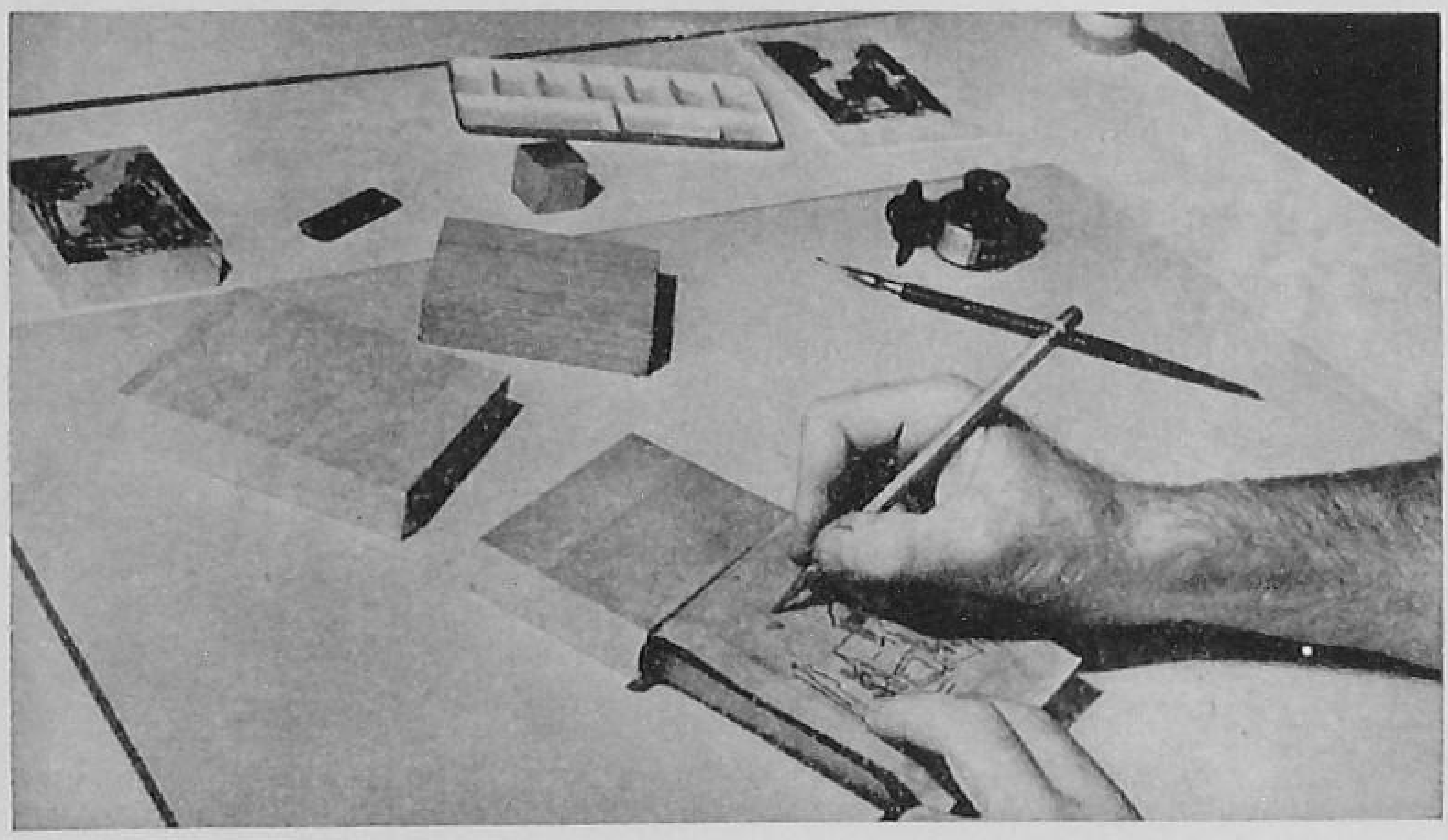


FIG. 34. Transferring to the block through carbon paper.

In either case your block is now ready for engraving. All the dense blacks are to be left standing as they are. The intermediary tones are shaded in with lines corresponding to their tonal values. The fully white highlights are to be routed out.

ENGRAVING THE BLOCK

Block Rest or Sandbag.

To hold the block firmly on the bench or table, a block rest or bench hook like the one described on page 17 may be used. Experienced en-

gravers, especially professionals, like to work with the block resting on a sandbag. See Fig. 37. Such a sandbag, made from leather, may be purchased from engravers' supply houses. The handy hobbyist can easily make one himself as described on page 18.

FIG. 35. Transferring with ammonia.

Choice of Strokes.

The direction of the strokes or lines with which the various tonal values are to be expressed must be chosen so that the combined impression on the eye will most nearly suggest the texture and perhaps even the color of the object depicted. Adjacent areas of the same tonal values may be delineated by a white outline between them, by leaving a black line standing, or by simply varying the direction of the strokes, as in sections *a*, *b*, and *c* respectively of Fig. 36.

Your handling of individual arrangements of lines into tone shapes and textures will improve after you have had to think out some of them by yourself. However, you need not rediscover it all over again. There is an

inexhaustible wealth of information to be found in the study of the masters of the craft and even in that of the lesser artists. Collect examples of good wood-engravings from book illustrations, newspapers and magazines, and study not only their art value, but primarily try to follow the minute details of the technique of cutting with which the effect has been obtained. This analysis or breaking down of someone else's work will supply you with a store of experience that will very soon manifest its influence on your own work. When you visit a museum or exhibition, do not flit from one exhibit to another for the mere pleasure of seeing a large volume of prints in a short time. Stop and let your mind go over the entire process of the working technique represented by perhaps only a small section of a print. See with your imagination the wash-tone drawing of the detail; formulate, in clear thought, the problem of the choice of stroke, and determine whether you would have chosen the same stroke as the artist or whether your own choice would have been as successful. This method of studying is not only instructive; it can and should be a source of enjoyment of a new and fascinating kind. In its own way it will do as much for the formation of your taste and working techniques as the actual cutting of many tentative blocks.

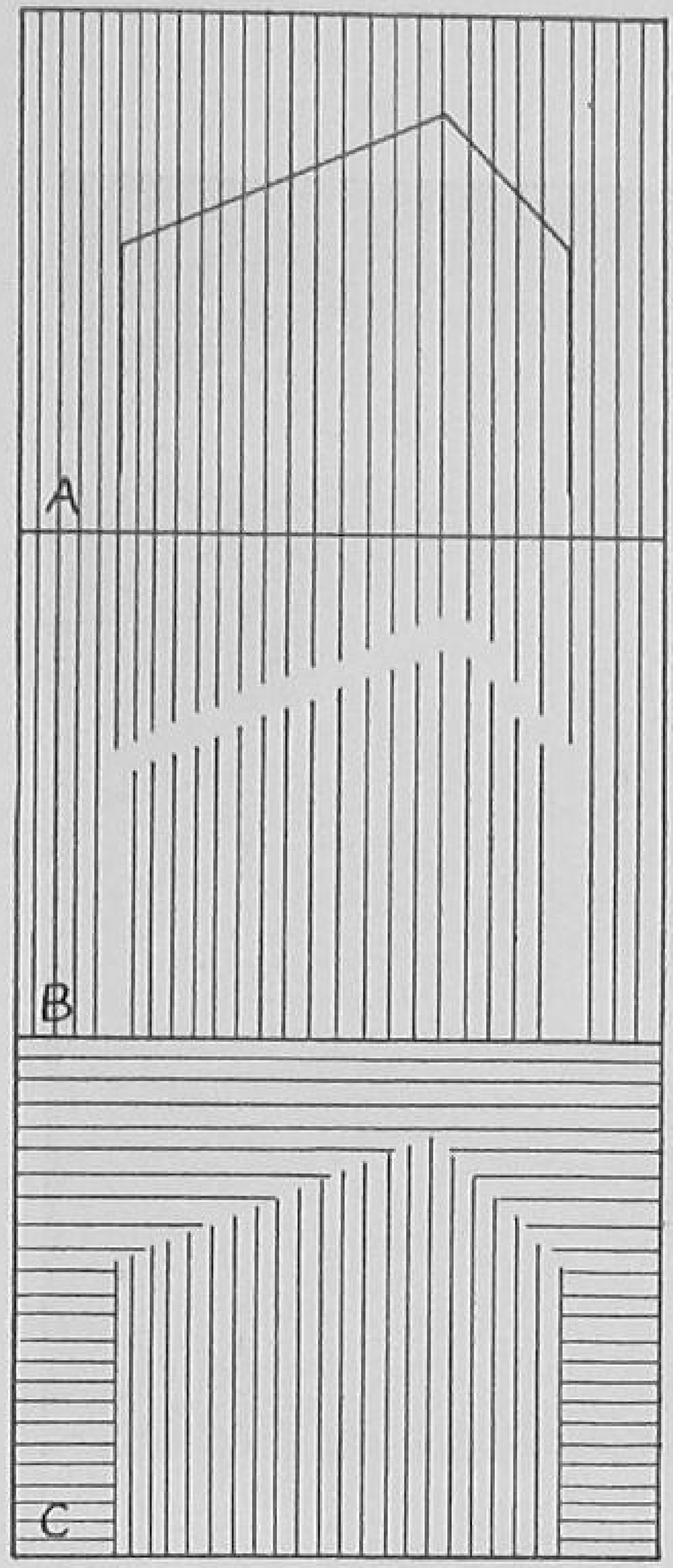


FIG. 36. Direction of strokes delineate same tonal values.

It has been repeatedly pointed out that wood-engraving is a slow process. It certainly cannot be done as swiftly as a drawing or a sketch on paper. Yet, if the cutting of a block is slow, it is nevertheless a highly fascinating experience, demanding and developing qualities of fidelity to detail and persistence in endeavor that will be found very valuable not only in the craft itself but in other fields also.

Printing the Wood Block

Ink and Inking.

Wood-engravings are printed in exactly the same manner as that described for the printing of type-high mounted linoleum blocks, p. 20-28. However, as the lines in a wood-engraving are usually much finer and closer, a smoother and finer ground ink should be used to bring out the full value to its best advantage. A good grade of half-tone black is recom-

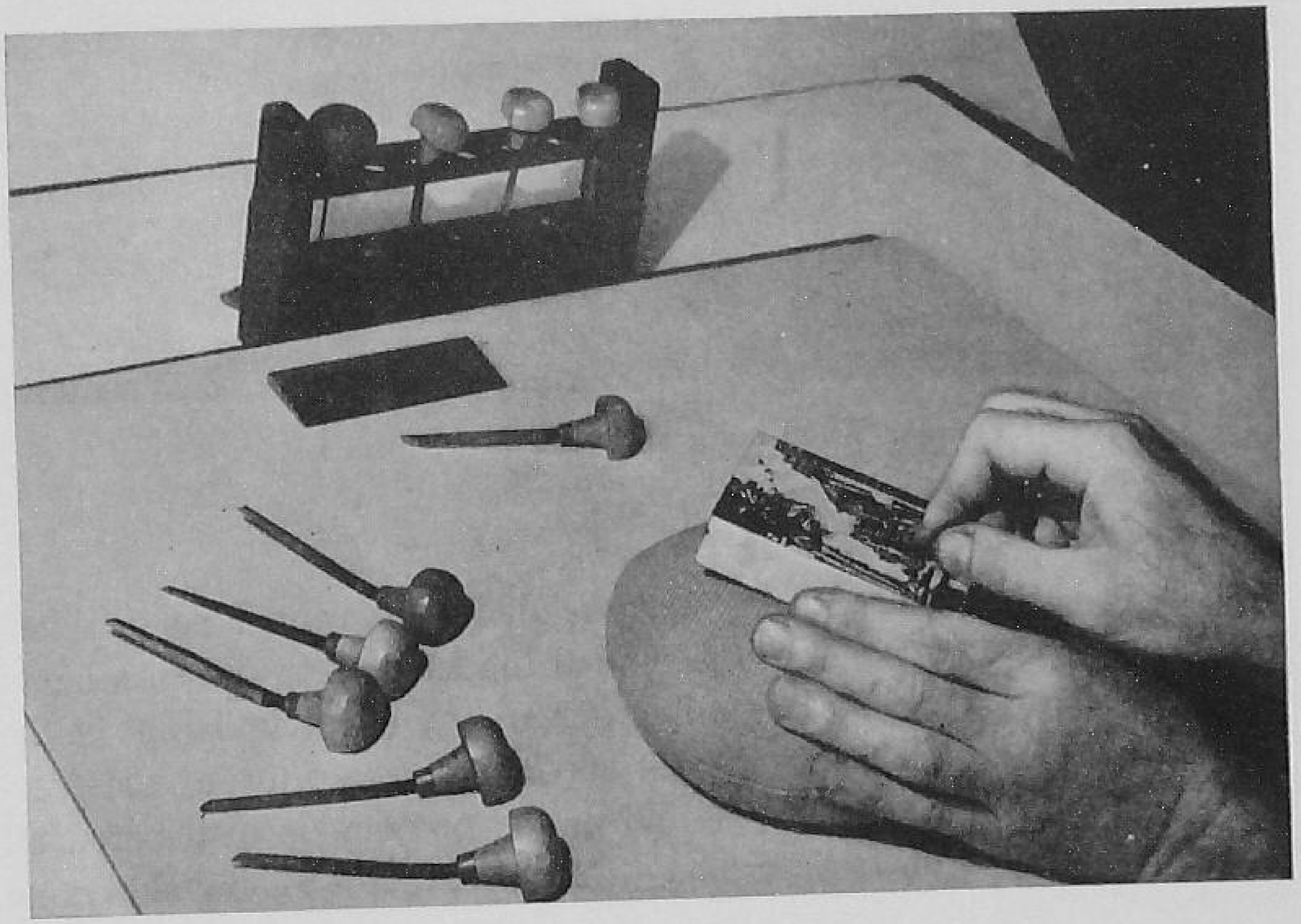


Fig. 37. Sandbag used to hold the block firmly.

mended. When inking an engraving by hand, great care should be exercised that the brayer is not run off the edges of the block; whenever this caution is relaxed, an excess amount of ink is banked up on the rim of the border and the border itself is left bare of ink. It is best to run the brayer over the block in several directions without exercising any pressure beyond the weight of the roller itself on the printing face. On a platen press the amount of ink on the inking disk must be kept well under control. Too much ink will result in a muddy impression, whereas just

too little will prevent the fullness of the contrast of black and white upon which the characteristic effect of the wood block so largely depends.

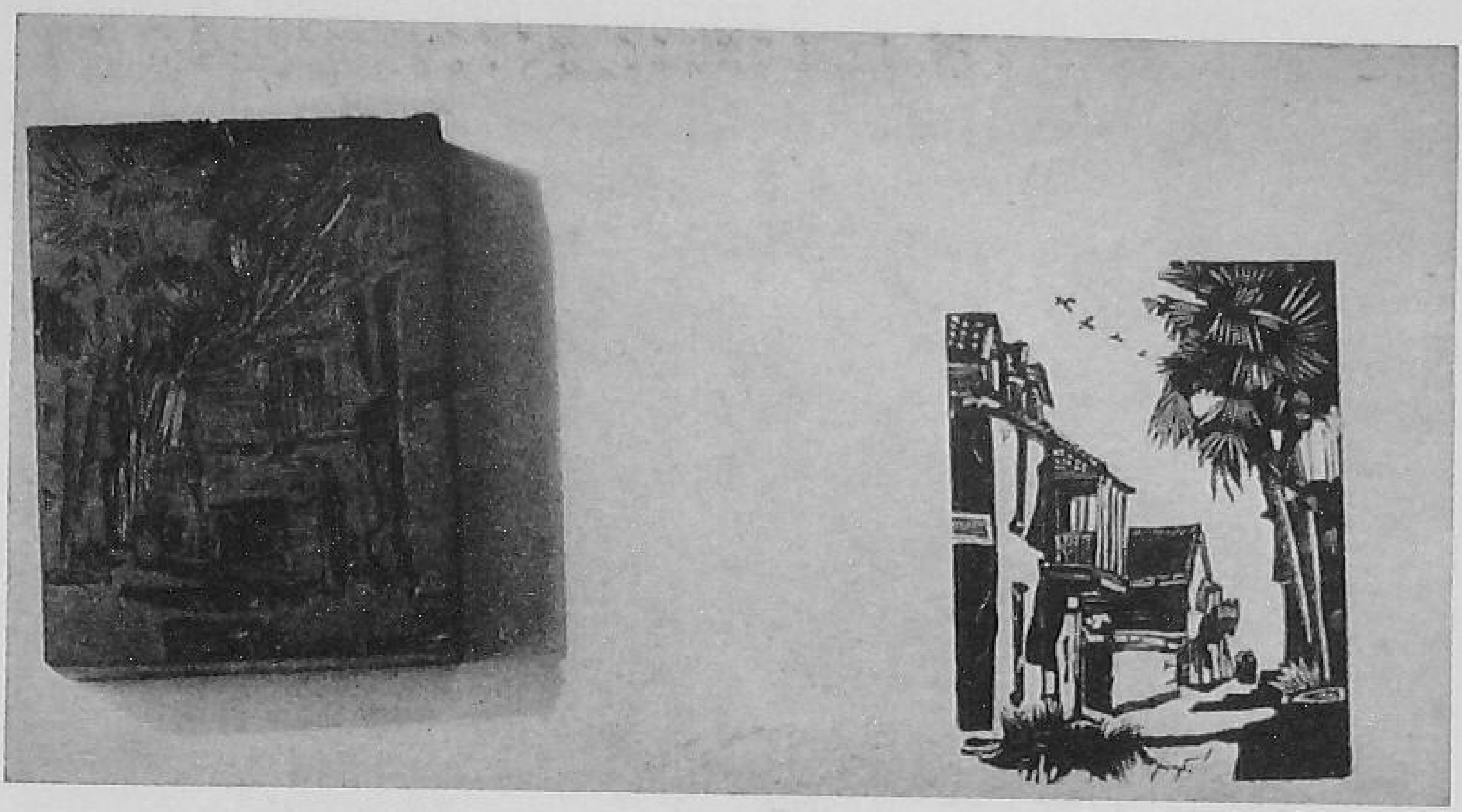


FIG. 38. Wood block and print made from it.

Make-ready.

Larger blocks may need some make-ready when printed on a platen press or on a printing gadget of the type of the letterpress. When a baren or burnisher is used to obtain the impression, any slight variation in the height of the block will not be greatly apparent in the print, as the pressure is distributed in small areas. When the pressure is distributed all over at once and the first prints show light areas, this is almost always an indication that the block has "low spots." These must be built up to full printing height. Cut the light areas out of the first print and paste the cut-outs under the corresponding place on the bottom of the block. If the area to be lifted is a large one and graduated in tone, cut a second inner spot and paste in the position under the wood. Now take another impression and compare it with the first one. If more light spots show up, repeat the whole procedure until your impression is perfectly uniform.

Printing by Hand.

When printing with a spoon or a baren, it is all too easy to injure fine, isolated lines in the block. A stiff sheet of red press board, such as com-

mercial printers use in the tympan packing of their presses, should be laid over the printing paper. Some hand printers find that lubricating this sheet with wax or tallow helps the action of the burnishing tool in gliding evenly over the surface.

Cleaning of Blocks and Brayers.

Never allow printing ink to dry on the block. To wash it off use only either gasoline or benzine. Turpentine or kerosene oil take a long time to dry. When printing is resumed with blocks that have been washed with either of these oils, the oil often oozes from the wood under pressure and adulterates the printing ink. If this happens, take a few impressions on dry absorbent paper from the uninked block, until all the oil has been squeezed from the fibers of the wood.

Your ink brayers, on the other hand, should be washed with kerosene only, as anything harsher may harm the glue-glycerine composition of the roller. After cleaning, hang your rollers up, away from heat and excessive sunshine. Coat them with a little ordinary machine oil to prevent shrinking in dry weather or swelling when the atmospheric moisture content is high. Never lay rollers flat on a table, since their own weight will tend to distort their roundness.

Color Wood-Engravings

Wood-engravings in color require, like multicolor linoleum prints, a separate block for each individual color. We have seen that black-and-white wood-engravings may express a wide variety of tonal shades and values. If we extend this versatility to another, or even several color blocks, we have a very wide gamut of nuances with which to work and which makes color wood-engraving an exceedingly interesting and challenging craft. Color wood-engraving requires, because of this wide range, a well-trained sense of color and values.

Chapter III

SILK SCREEN PRINTING

The Process

Silk screen printing is the youngest of the graphic arts processes. In the short span of time since the first decade of our present century it has developed from its obscure and crude stencilling predecessors into a full-fledged industry, employing thousands of skilled craftsmen. More recently—within the last twenty years—silk screen has matured into an art medium in which outstanding artists make decorative prints that rival in artistic value those produced by the more traditional methods of block-printing, etching and lithography.

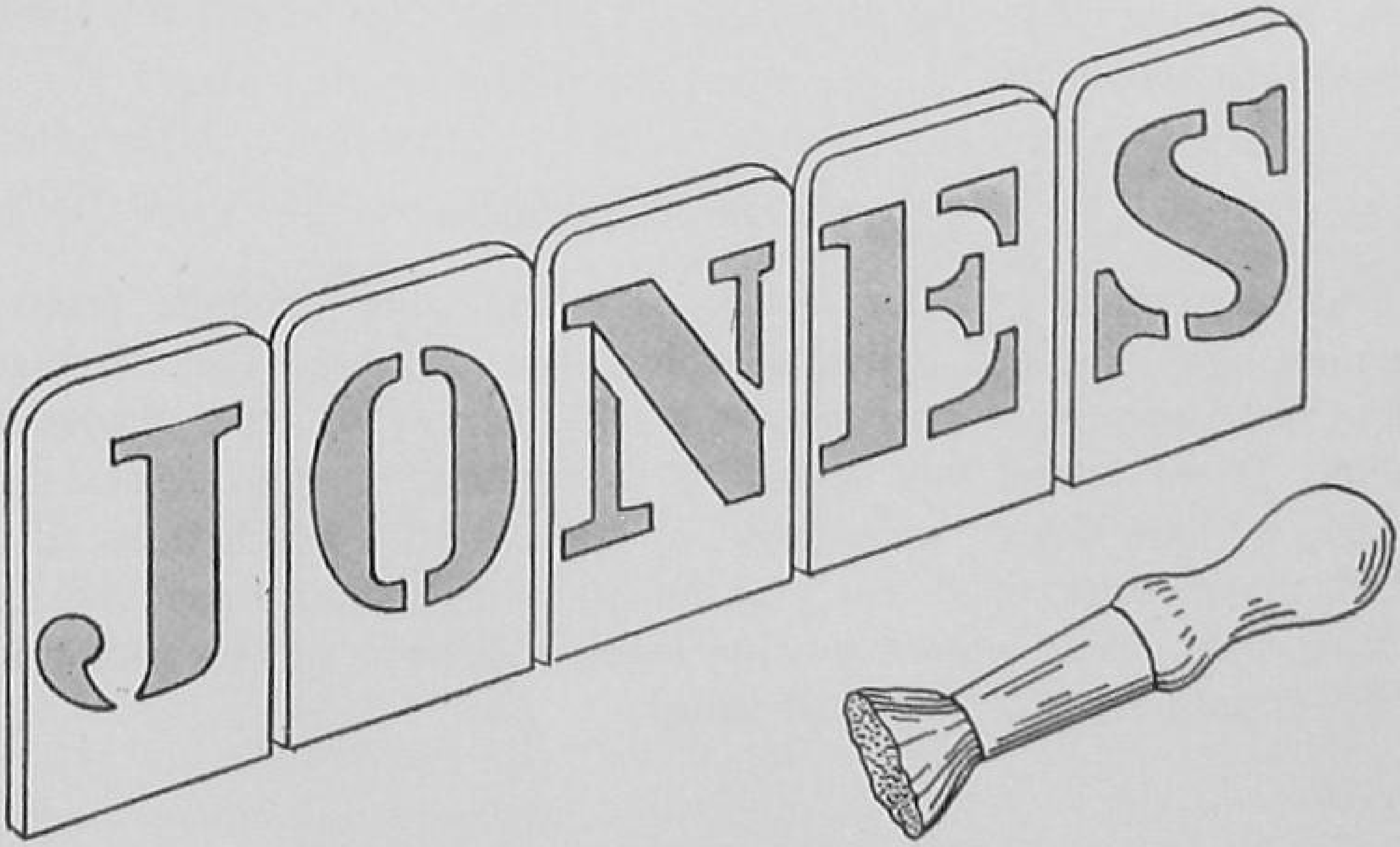


Fig. 39. Bridge-tie metal stencils.

The idea of applying decorations by stencilling is, of course, a very old one. Evidence shows that it was known and widely practiced in ancient China. We are all familiar with the present day cut-out lettering devices

and brushes which shipping clerks use to mark packages and crates. Painters and interior decorators have long applied decorative repeat borders to painted walls through cut-out oil-paper stencils.

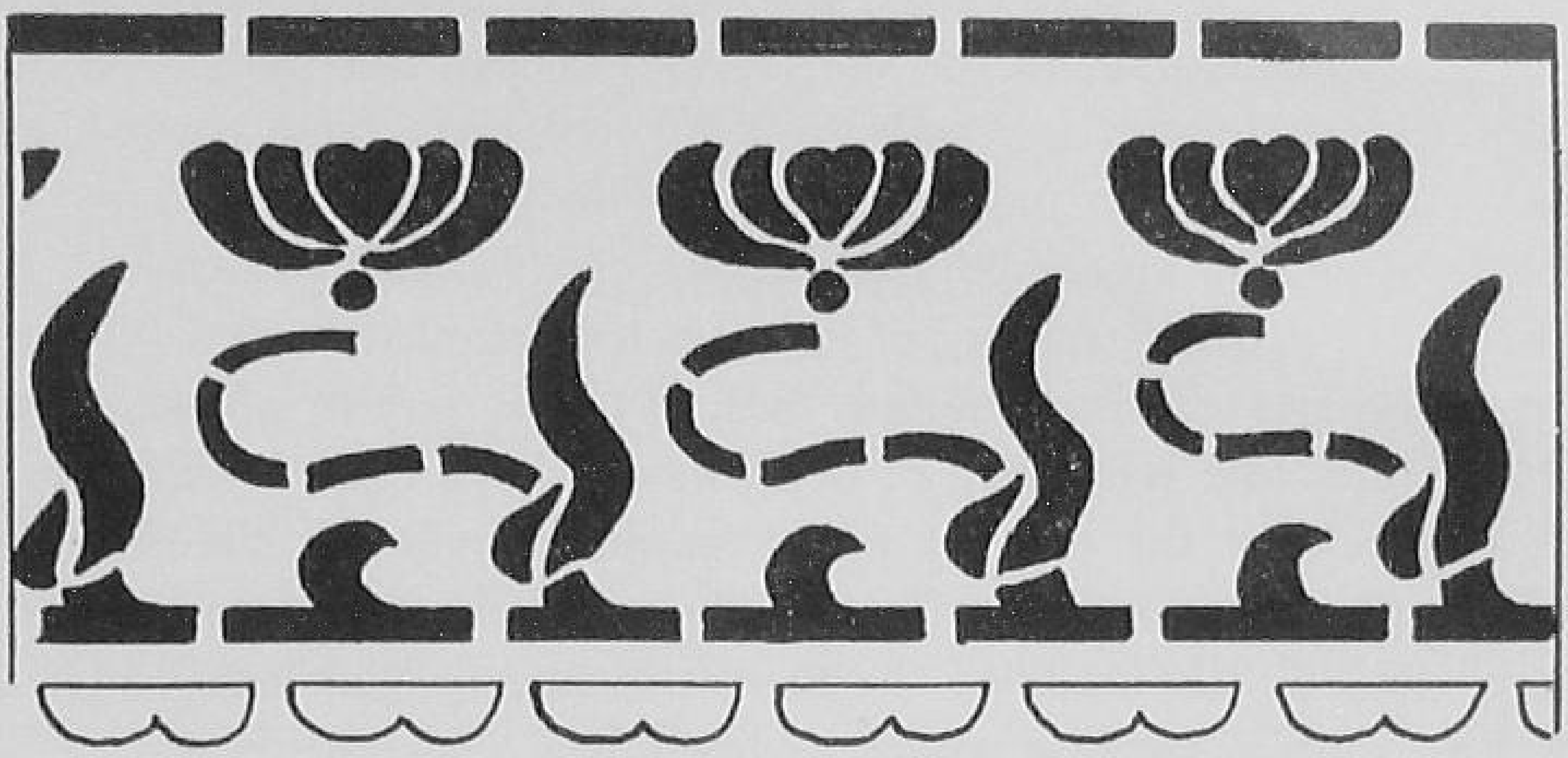


FIG. 40. Wall painter's repeat border stencil. Note ties.

All these stencils had the one drawback in that isolated islands of either metal or paper in the design had to be held in place by small bridges left in the material, which later showed in the reproduction as interruptions in the color areas. See Figs. 39 and 40.

The Origins of Silk Screen Printing.

The search for a way to eliminate these unsightly gaps in stencilled designs led to the discovery of the silk screen. The tightly stretched silk holds all parts of the stencil permanently in their right positions, and yet allows the paint to be squeezed through the open mesh of the silk around them.

When and exactly where the discovery was actually made are not quite clearly established. France, Germany and England have claimed credit for it at one time or another. The first official record of silk screen printing, as we know it today, is that of a patent issued in England in 1907 to Samuel Simon of Manchester. Since then the contributors to its development in both its commercial and fine arts application have been numerous, adding each a little to the accumulated fund of knowledge, until today the "secrets" of the process have become the common property of all.

Its Many Uses.

The evident advantages of the process as an efficient and economical method of graphic reproduction were at once recognized, and its use has rapidly spread into the most varied branches of modern industrial and commercial activities. Posters and display cards, greeting cards and book jackets, glass plates and mirror signs, neckties and felt pennants, bottles and jars, toys and novelties made from all materials, paper, wood, metal, leather and plastics are today printed or decorated by the silk screen method in countless ingenious applications of the basic principles. A variety of stencil-making techniques have been developed to satisfy the specific requirements of these varied uses. Process paints of standardized uniform quality and reliability of performance have been evolved by consistent research on the part of paint manufacturers. A sizeable supply trade has sprung up in the wake of the rapid development of the new industry, swelling the ranks of the many thousands who today look upon silk screen printing as their source of livelihood.

Silk Screen Printing Is Inexpensive and Versatile.

One of the factors accounting for the rapid springing up of countless small silk screen printing ventures all over the country is no doubt the fact that its commercial practice requires only a relatively small investment of money in equipment. It is essentially a handcraft process, using no expensive machinery. The amateur silk screen printer can even make his printing frames at home at little or no expense.

Silk screen printing is fascinating as a hobby or as a full-time occupation, offering rich opportunities for artistic self-expression and the application of creative imagination. It is versatile in its practice, being adaptable, as we have seen, to the printing on many surfaces and articles upon which the older techniques could not be used. It is also versatile in its effects, which may range from the transparent appearance of a water color to the heavy impasto of a gouache or an oil painting. Yet it is not merely a substitute for either, having a charm and character all its own.

Fine Arts Serigraphy.

Parallel with the commercial development of silk screen printing, the movement of fine arts painting in the medium called *serigraphy* has made enormous strides in the last two decades. Some of our highest-ranking art museums and galleries already have permanent collections of serigraphs, and group and individual exhibitions all over the country are highly suc-

cessful each year. More and more artists of great ability are constantly attracted to serigraphy and use it as their favorite medium of expression. A National Society of Serigraph Artists has been organized and their screen art prints are today accepted in all circles on the same footing as prints by the older media. They are shown, discussed by the art critics of the press, and—the acid test—they are bought as genuine works of art by an ever increasing public.

The Frame and the Screen

Whether you want to do silk screening as a decorating supplement to some other hobby, as a business proposition, or as an art expression, or whether you intend to use any or all of the five different methods of making your stencils, you need as basic equipment a sheet of silk and a frame on which to stretch it. Complete beginner's units made up of all the required tools and small quantities of each of the supplies needed, including paints, may be bought from art stores at a cost of a few dollars.

Many supply houses issue catalogs and price lists on screen fabrics and stencil materials as well as color charts of their process paints. The student should write to them and keep these catalogs in his files. They supplement any book of instructions by furnishing specific answers to the ever first questions: "Where can I get it, and what will it cost?" The addresses of such supply houses may readily be found in the classified telephone directories of the larger cities.

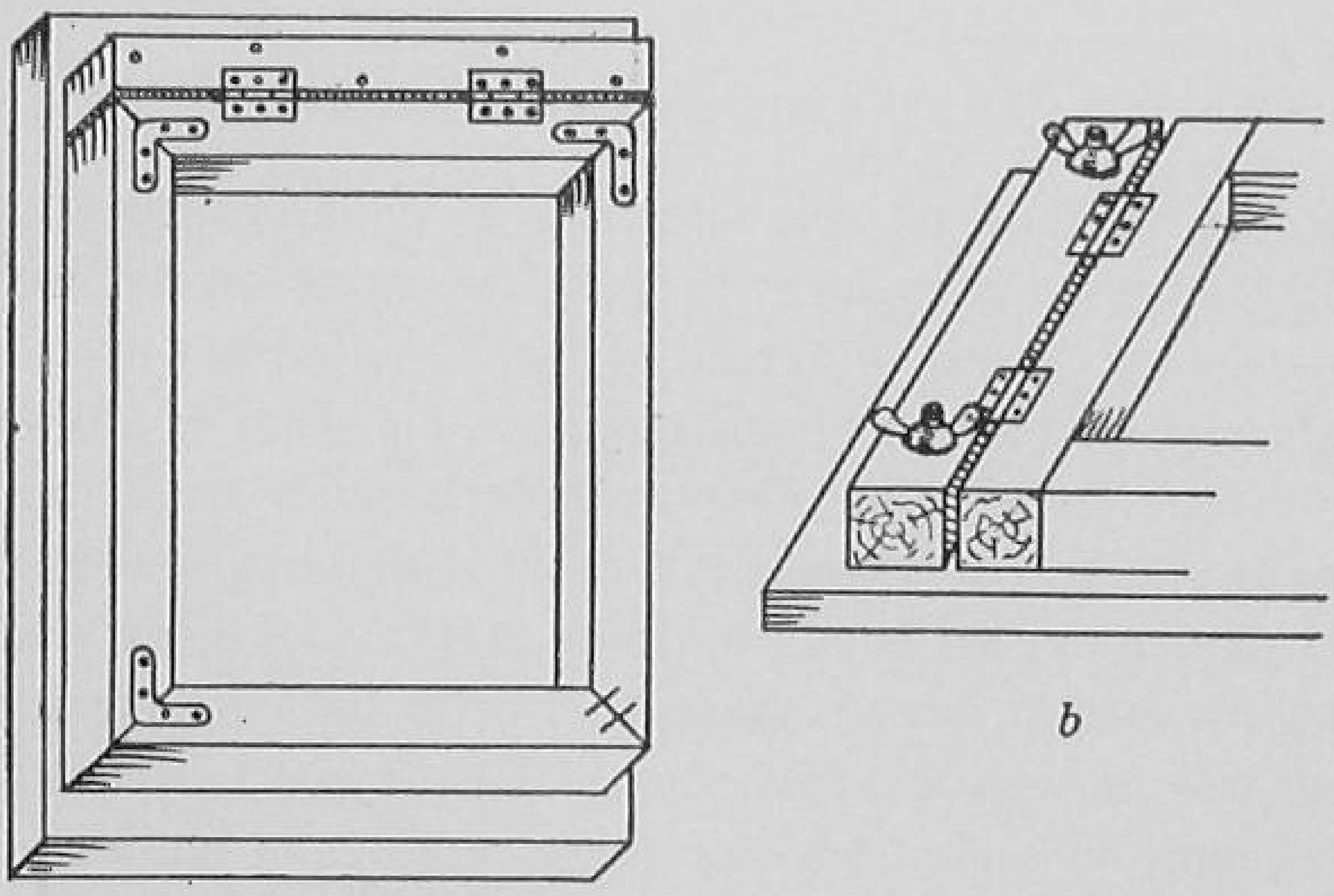
The Printing Frame.

For the craftsman who wants to make his own frames the diagram in Fig. 41 shows the detail of construction. The dimensions are of course governed by the size of the prints you intend making with the frame. The inside length of the screen frame should be at least 6″ longer than the largest stencil to be used in it in order to provide adequate reservoir space for the paint at both ends. Standardized commercial frames are made in sizes from 8″ x 10″ to 48″ x 60″. The four members should be at least 1¼″ high.

When the silk is to be attached to the frame with carpet tacks, the four strips of wood may be joined by any method you prefer as long as it will give you a rigid frame that will lie flat. Another method of fastening the screen fabric is to cut a groove in the underside of the wooden members of the frame and wedge the silk into this groove with a cord. In this

method the sides must be assembled with a 45-degree miter joint to assure the continuity of the groove all around the four sides.

For the larger sizes of screens it may be advisable to reinforce the corners with iron angles. All screens, when finished, should be given a coat of shellac to seal the pores of the wood. This precaution will greatly facilitate the cleaning of the screen after printing.



a *b*

FIG. 41. (*a*) Construction details of printing frame push-pin hinges, (*b*) Alternative method of assembling frame and base. Fast hinges, bolts and wing nuts.

The baseboard can be made from an old drawing board or a piece of plywood, slightly larger than the outside of the frame. A crossbar of the same thickness as that of the frame is attached at one end, and the frame is fastened to this with two hinges. If these hinges have removable pins, the crossbar can be nailed or screwed firmly to the base. When common butt hinges with fast pins are used, the crossbar must be bolted to the base with machine screws and wing nuts. In either case, the frame itself or the frame and crossbar together must be readily removable from the base. The second method has the advantage of allowing the frame to be adjusted for printing objects of varying thickness, as we shall see later.

Screen Fabric Materials.

Pure silk makes the most satisfactory screen material. It is obtainable from supply houses in a variety of mesh counts, under the name of bolt-

ing cloth. The mesh count is indicated by a number. No. 8XX or No. 10XX will be found satisfactory for all paper and film stencilling. No. 8 silk has 86 meshes to the inch, and No. 10 has 110 meshes. The XX annotation after the mesh number denotes the grade of the silk, in reference to the number of strands that make up the individual threads. The better the grade, the more often the silk may be reclaimed for re-use. It will withstand a greater number of washings with the various harsh solvents. The standard width of bolting cloth is 40″.

Some screen printers recommend the use of organdy instead of silk, mainly because of its much cheaper price. However, organdy screens do not last as long as silk ones do, and they have the further disadvantage that they are likely to stretch and become flabby in the course of printing. It is often difficult to obtain proper register of colors with them, which makes the saving in money a questionable advantage.

Attaching the Silk to the Frame.

Remove your frame from the baseboard and turn it over. Spread the bolting cloth over it so that the warp threads run parallel with the sides of the frame. The woof is then lined up with the top and bottom bars of the frame. Tack the silk to the wood with a few, small, flat-headed tacks (#4 carpet tacks), at the center on one of the long sides. Stretch it evenly to the opposite side and tack it to its center. Do the same thing to the remaining two sides, and then work from each center to the corner, pulling evenly before placing each tack. Fig. 42. Trim off any surplus silk with a scissors and paint the silk on the frame with shellac. When dry, paste a strip of gummed paper over the nailheads all around the frame.

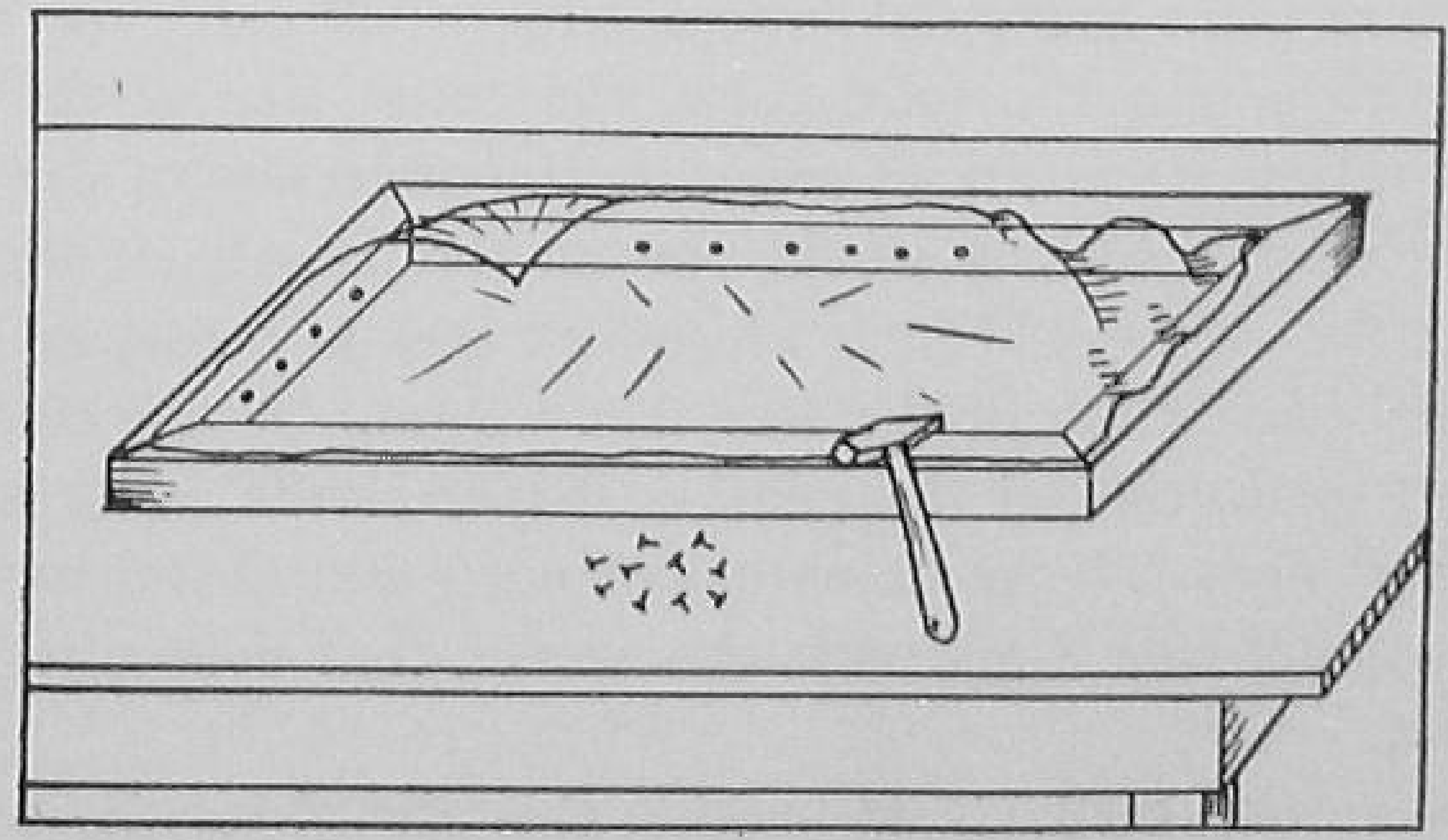


FIG. 42. Attaching the silk with carpet tacks.

If your frame has been made with a groove, spread the silk over it and start to force the cord into the groove, pressing silk and cord into it with your fingertips, at the same time pulling the silk as tight as you can. When completed, drive the cord down into the groove with a blunt wooden wedge and a mallet. This will make the silk as tight as is required at the present. See Fig. 43.

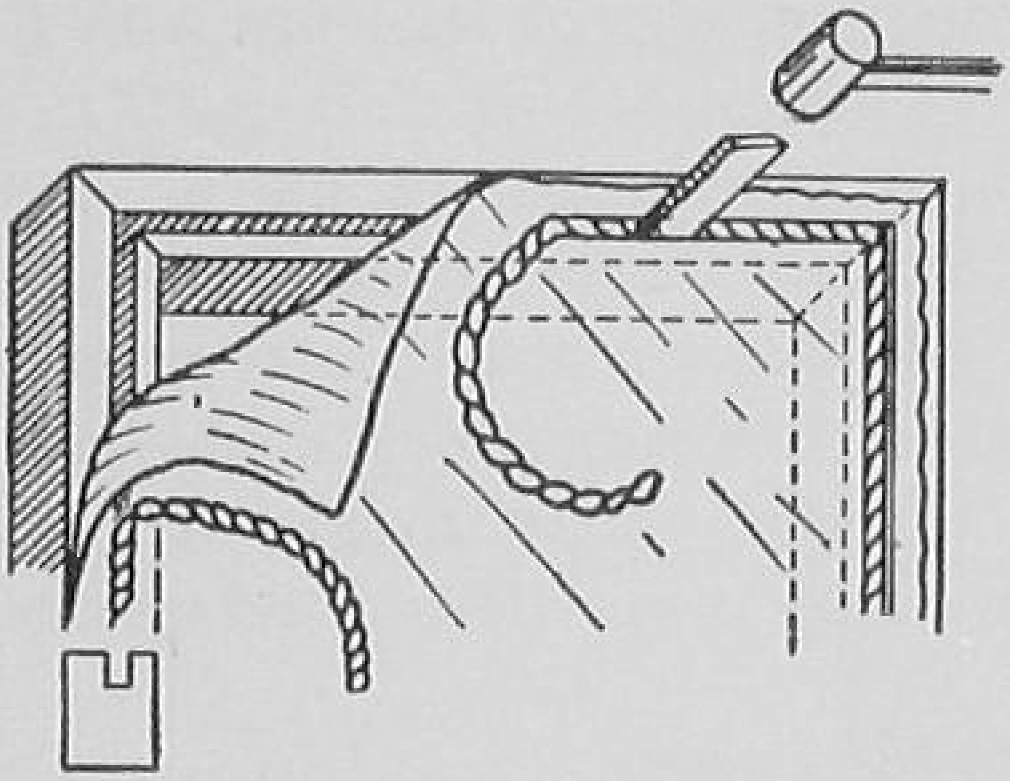


FIG. 43. Forcing cord into the groove of a frame.

After being mounted on the frame by either of these methods, the new silk will have to be washed and soaked in warm water to remove all sizing that it may contain. Upon drying, the fabric will slightly shrink and will be stretched quite taut on the frame.

THE STENCIL

Your printing frame is now ready. If you were to pour paint into it and squeegee or print this paint onto a large white card, the card would be printed with a uniform, solid color, the entire size of the screen. If you were then to paste a disk of paper on the underside of the screen and print another card, the paper would prevent the passage of the paint and the result on the card would be a white disk area in a colored field. This is a simplified illustration of the fact that we can, by masking out parts of the screen mesh, control the relative shapes of the white and printed areas of our design. The combination of open and closed mesh areas is called the printing stencil and it is this stencil that determines the shape of your print.

There are several methods of making this stencil on the screen. The simplest is the use of stencilling paper, which no doubt must have been

the medium of the pioneers in the craft. Its technically matured version, the lacquer film stencil is, like its forerunner, a separately prepared material that is cut with a knife and is later adhered to the screen fabric. The lacquer or shellac block-out stencil, and the tusche-glue stencil are directly painted onto the silk with a brush. The very latest advance in stencil making is the photographic stencil method, which is still more or less in a process of evolution at the present time.

The student will readily see that the making of the stencil constitutes the central core of the silk screen printing craft. Upon it depends the success or failure of the work. The choice of the particular method of making the stencil will be determined by the nature of the subject itself, as well as, of course, the materials the artist has available. We shall examine each stencilling method in turn, and then study the printing procedure common to them all.

Preparing the Art Work

It has already been pointed out that almost any kind of picture or lettering may be reproduced by process printing. The beginner, however, should confine himself to cutting stencils in which the design is handled in flat, solid color areas. Very fine lettering and delicate shading effects are better reserved for the time when the operator will be prepared to make use of the more accurate photographic stencil. These reservations should be borne in mind when the original art work is drawn up, and the latter should conform to the requirements of these limitations.

When the design consists only of large, flat masses and simple lettering and is to be printed in a single color, a mere pencil sketch may be sufficient, provided it is made with clean, thin, accurate lines. Copy for multicolor printing should be done in full colors, finishing the drawing with either crayons or water colors. This colored working drawing should preferably be made on a card of exactly the same size as the stock on which the design is to be printed. If this rule is observed, the registering of the stencils for each color and the successive printings can all be done from one setting of the guide stops on the frame, and accurate register should present no further difficulty.

For a first stencil, the beginner will be well advised if he selects a simple silhouette design with not too much detail. Through it he may get an easy yet thorough introduction to the equipment, the materials and the

working processes, so that he may approach his further, more elaborate efforts with more freedom of action.

The Paper Stencil Method

Limited Use.

The paper stencil should be chosen for work of the simplest nature only and when only a limited quantity of prints is required. Simple signs and posters, with flat areas and large lettering, and silhouette pictures devoid of fine detail and shading may be cheaply produced with this least expensive stencil-making process.

The Stencil Paper.

The paper used for stencilling should be thin and strong, yet somewhat absorbent. It must be thin so that the outlines to be cut can be seen and also to keep the thickness of the layer of paint on the print to its minimum. The paint layer will be as thick as the stencil paper. If no transparent paper is available (never use wax-paper), you may render a sheet of lightweight bond translucent by rubbing a little oil on it with your fingertips. Art stores carry a special paper made for stencil cutting. It is quite cheap and, wherever available, its use is recommended in preference to substitutes.

Cutting and Adhering the Stencil.

Lay a sheet of thin zinc on the baseboard of your frame. On it fasten an accurate, neat tracing of your lettering or design, and on top of it place your stencil paper. No reversing is required in this process, as the printing is done through the screen and not from it.

With a very sharp, small knife of the type illustrated in Fig. 45, cut through the paper along all lines of the design. Do not remove the bridgeless islands in the letters or design. Leave all these severed parts in their respective places and positions. When all the cutting is done, remove the thumbtacks or tape used to hold the paper in place. Do not disarrange the cut-out design while loosening. Now lower the screen over the stencil slowly so as not to create an air current that would blow away the loose parts of the stencil. Make sure that the silk is in tight contact with all parts of the design.

Pour process paint of a rather heavy consistency on the screen and squeegee it once or twice over the entire screen. Lift the frame up, and

you will find the stencil adhered to the silk. With tweezers, strip all the parts that are to be open for printing, leaving the islands in their position. You are now ready to proceed with the printing. With a little practice and the exercise of ordinary care in handling you may print up to fifty or even more good prints from this stencil.

The Shellacked and Ironed-on Stencil.

For larger runs, the paper stencil must be adhered more reliably. Follow this procedure: coat your stencil paper with a soft brush and shellac and let dry thoroughly. When dry, make sure that the shellacked paper lies perfectly flat over your tracing on the base of your frame. If clear

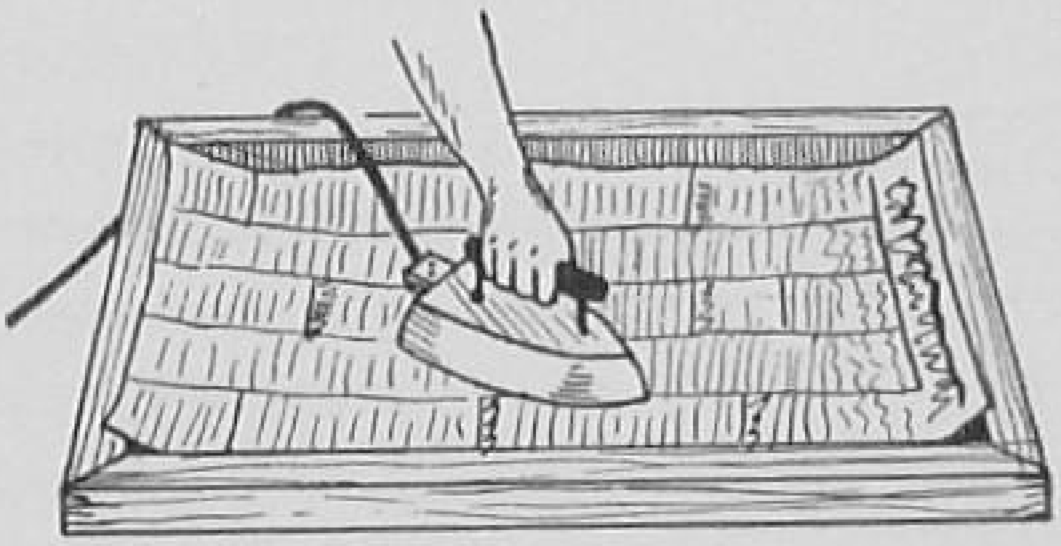


FIG. 44. A warm (not hot) iron is used over newspapers to adhere the shellacked stencil.

shellac has been used, the lines of the tracing will be clearly visible. If orange shellac was only available, the tracing should be inked so as to make it more clearly discernible through the stencil material. Cut all the outlines as above, but this time strip all the printing areas out of the stencil. If necessary, you will have to rearrange the islands in their places over the tracing after all the cutting is completed. Lower the silk carefully onto the stencil. Lay one or two sheets of folded newspaper in the frame, right over the top of the silk, and pass a warm flatiron over the whole area. The iron should not be hot but merely warm; too much heat will melt and burn the shellac. See Fig. 44. You want it just to soften a little so it will adhere to the silk.

Removing the Stencil.

To remove this stencil from the silk, use a cloth saturated with alcohol, and dissolve the shellac. Wash any remnant of it out of the mesh of the silk with the same solvent. The unshellacked stencil will, of course, drop off the screen as soon as the paint is cleaned from the silk.

The Film Stencil Method

The most widely practiced stencilling method is that which makes use of a prepared film material obtained from art stores or process supply houses.

Films.

These films consist of a translucent glassine paper back which has been covered with a smooth, thin coat of lacquer. The dried layer of lacquer is the stencil material proper, while the glassine backing is merely a convenient carrier for it.

Film materials are sold under various trade names. The most widely known are Profilm, a greenish sheet, Blu-Film of a blue-gray color, and amber-colored Nu-Film. It may be had in sheets of about 30″ x 40″ or in continuous rolls of 8½ yards in length.

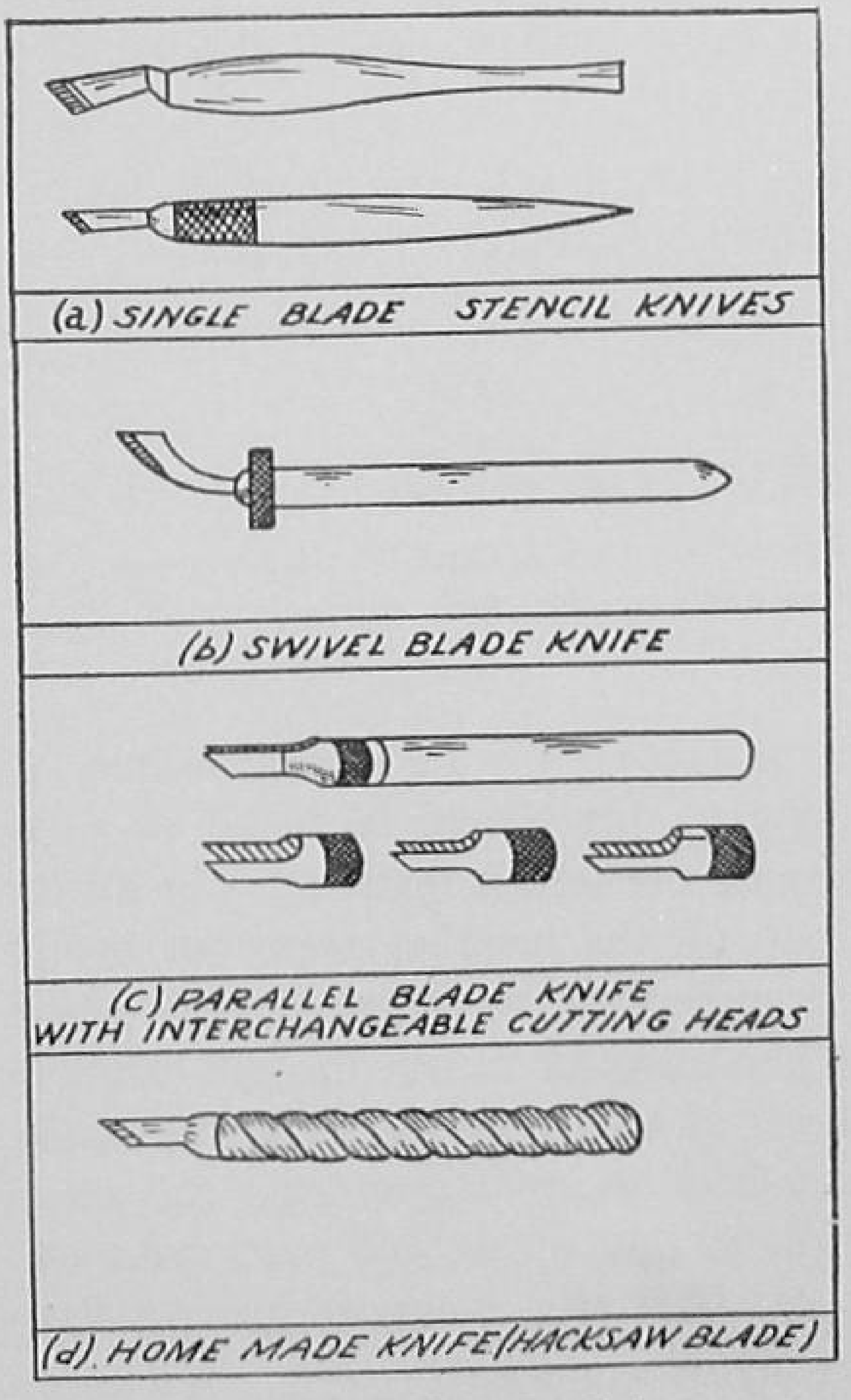


Fig. 45. Stencil-cutting knives.

Stencil-cutting Knives.

Stencil-cutting knives are sold in many various designs and shapes, from the simple one-blade knife shown in Fig. 45*a*, to the specialist's swivel-blade knife (*b*) and the double-bladed tools with many interchangeable heads of various spacings (*c*).

You can make a very serviceable knife yourself out of a piece of hacksaw blade. Grind the end of a 5″ to 6″ length of hacksaw blade to the shape indicated in Fig. 45*d*, and wrap adhesive tape in several layers around the rest of the piece to make a handle.

The knife should be light and convenient to the hand and have its blade sharpened to the keenest edge possible. A fine Arkansas oilstone should

always be at hand to touch up the knife at intervals. We shall later see the disturbing effect of cutting film with a dull knife.

Preparing the Stencil for Cutting.

From your supply of film material cut a sheet about an inch larger in all four directions than the outside dimensions of your copy or the original to be reproduced. Place the original, face up, on a thin sheet of zinc or pressboard, or some other hard surface like a stiff Manila folder. Do not use a soft, spongy paper padding that would allow the knife to emboss the paper backing of the film in the cutting of the lacquer. Center your stencil sheet, lacquer side up, on the drawing, so that the margin allowance is the same all around. Attach both drawing and stencil to the base with Scotch tape or masking tape. You will be able to see clearly even the faintest lines through the lacquer and you are now ready to cut your stencil.

Cutting the Stencil.

To cut even a thin, straight line out of the lacquer coating requires four cuts to be made with the knife. See Fig. 46. Irregular shapes are cut along their outlines. Rulers and French curves may of course be used wherever the shapes permit.

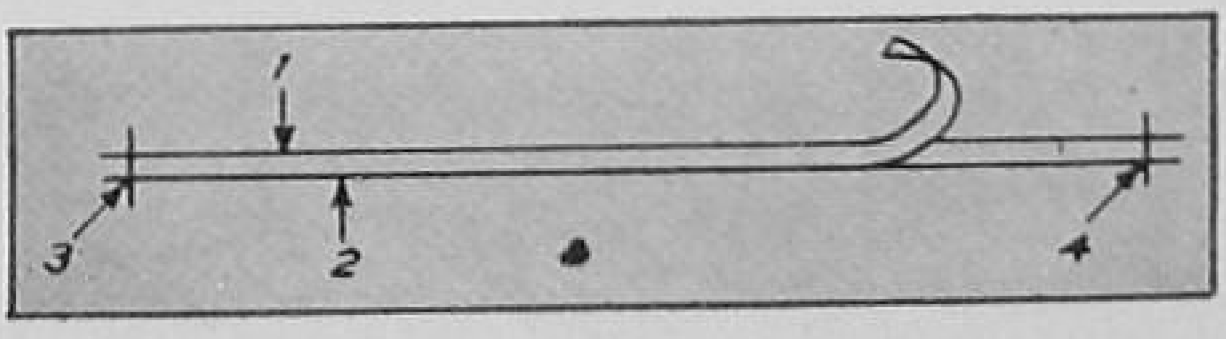


FIG. 46. Four knife cuts are required to cut a straight line.

Cut through the lacquer top of the film, but not through the paper backing. We want to keep this glassine back intact so as to hold all the isolated islands of the lacquer in their places and positions. Hold the knife like a pencil and cut with clean, neat cuts. A little practice on a scrap piece of film will quickly give you the feel of the knife and the amount of pressure to exert with it. See Fig. 47.

As soon as an area has been fully outlined with the knife cut, raise the lacquer coating at one end with the point of the knife and strip it from the backing paper with tweezers. See Fig. 48. When all the areas

that are to print are stripped out in this fashion, your stencil is ready to be adhered to the silk. In the larger areas from which you have stripped the lacquer, make a single knife cut through the backing paper to allow for the escape of any air that may get trapped when you adhere the stencil.

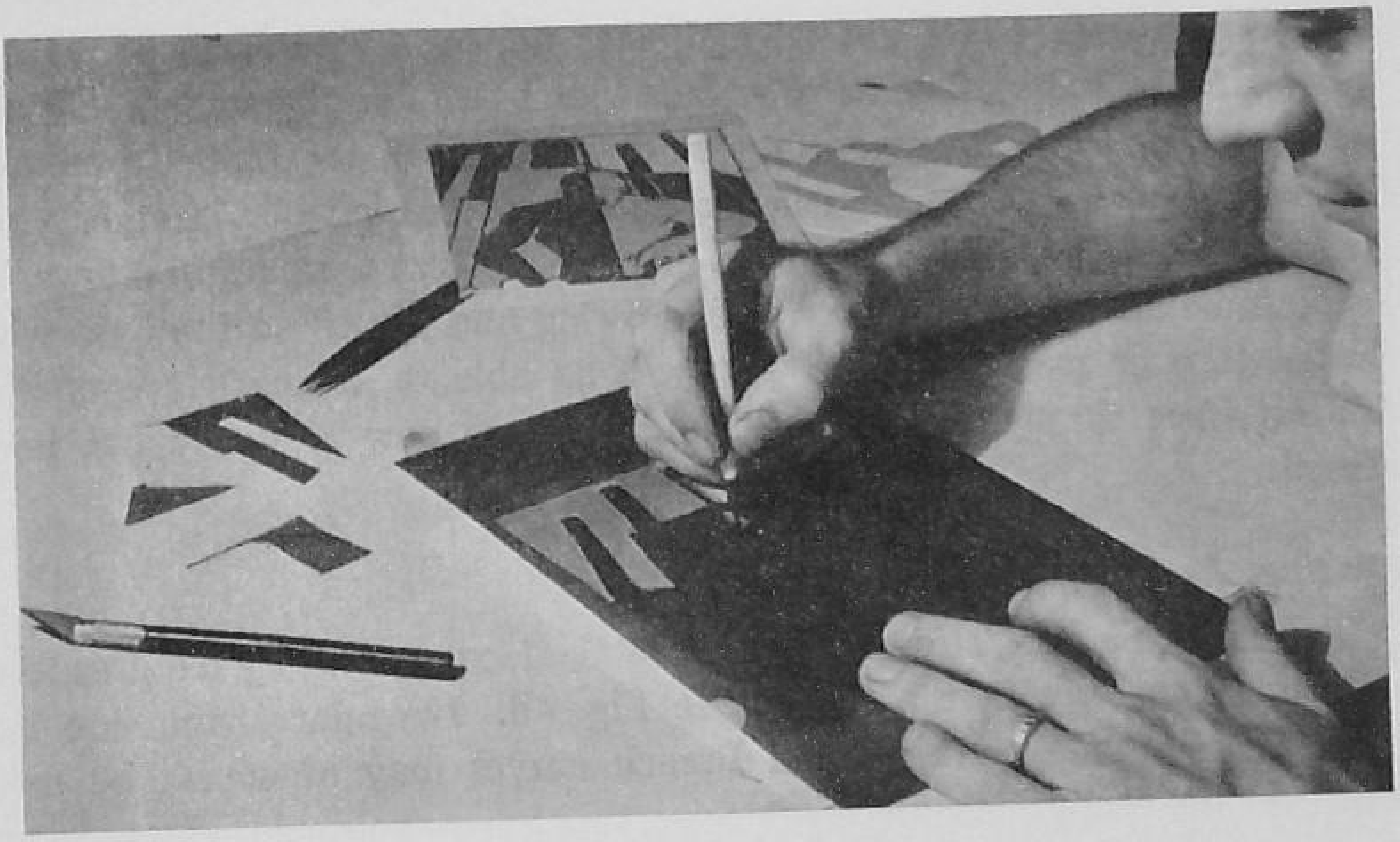


FIG. 47. Cutting the stencil.

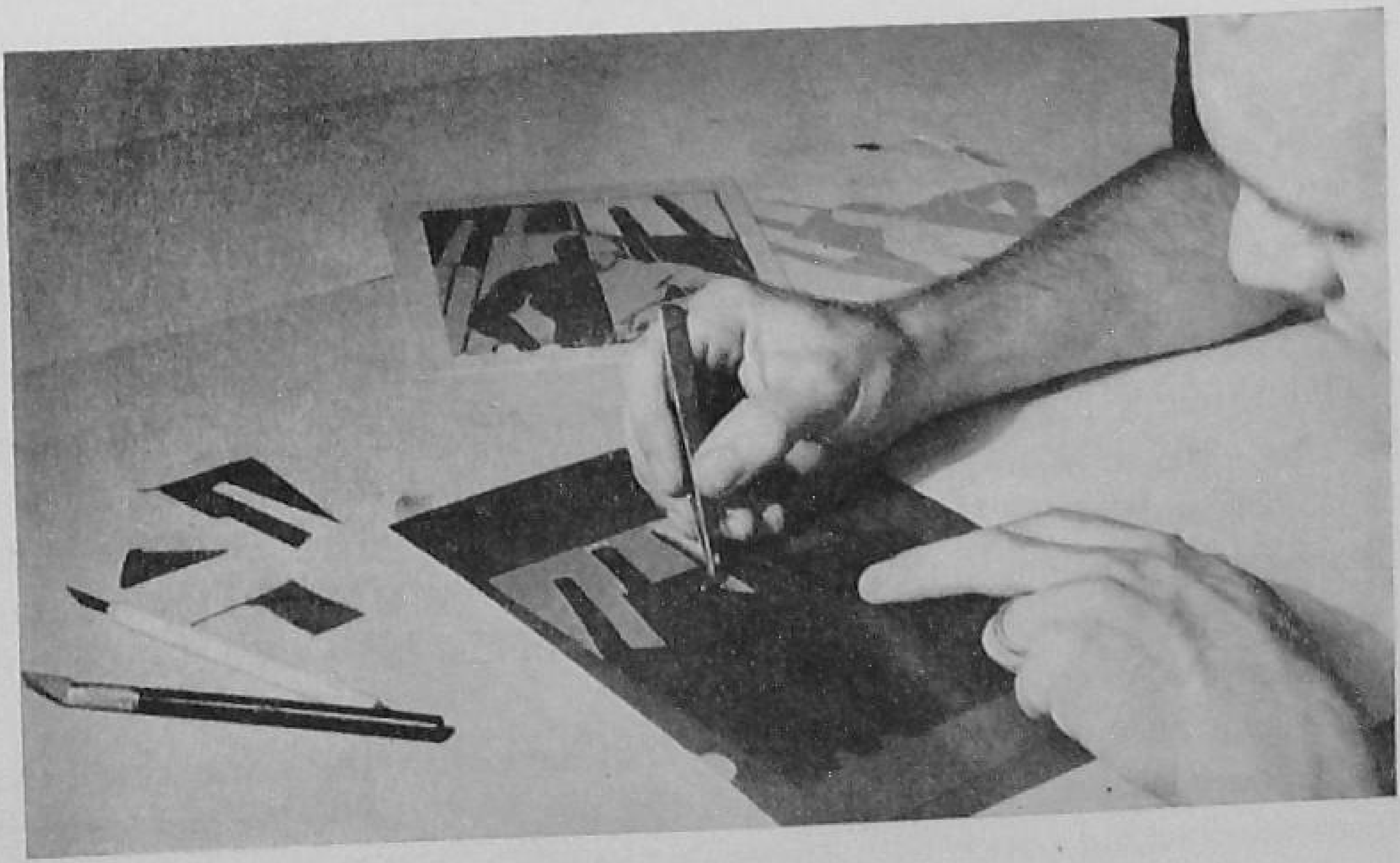


FIG. 48. Removing a cut-out area.

The cut stencil is removed from the cutting base and is either adhered right away or may be stored for use at some further date. When storing cut stencil, it should be rolled up, the lacquer side to the outside. Wrap it in a piece of paper to protect it against accidental scratching or peeling of any parts.

Preparing the Frame.

We shall now get the frame ready to receive the stencil. If the new silk has not yet been washed, do this now, with warm water and a little soap. Rinse well and let the fabric dry thoroughly. Then soak a cloth

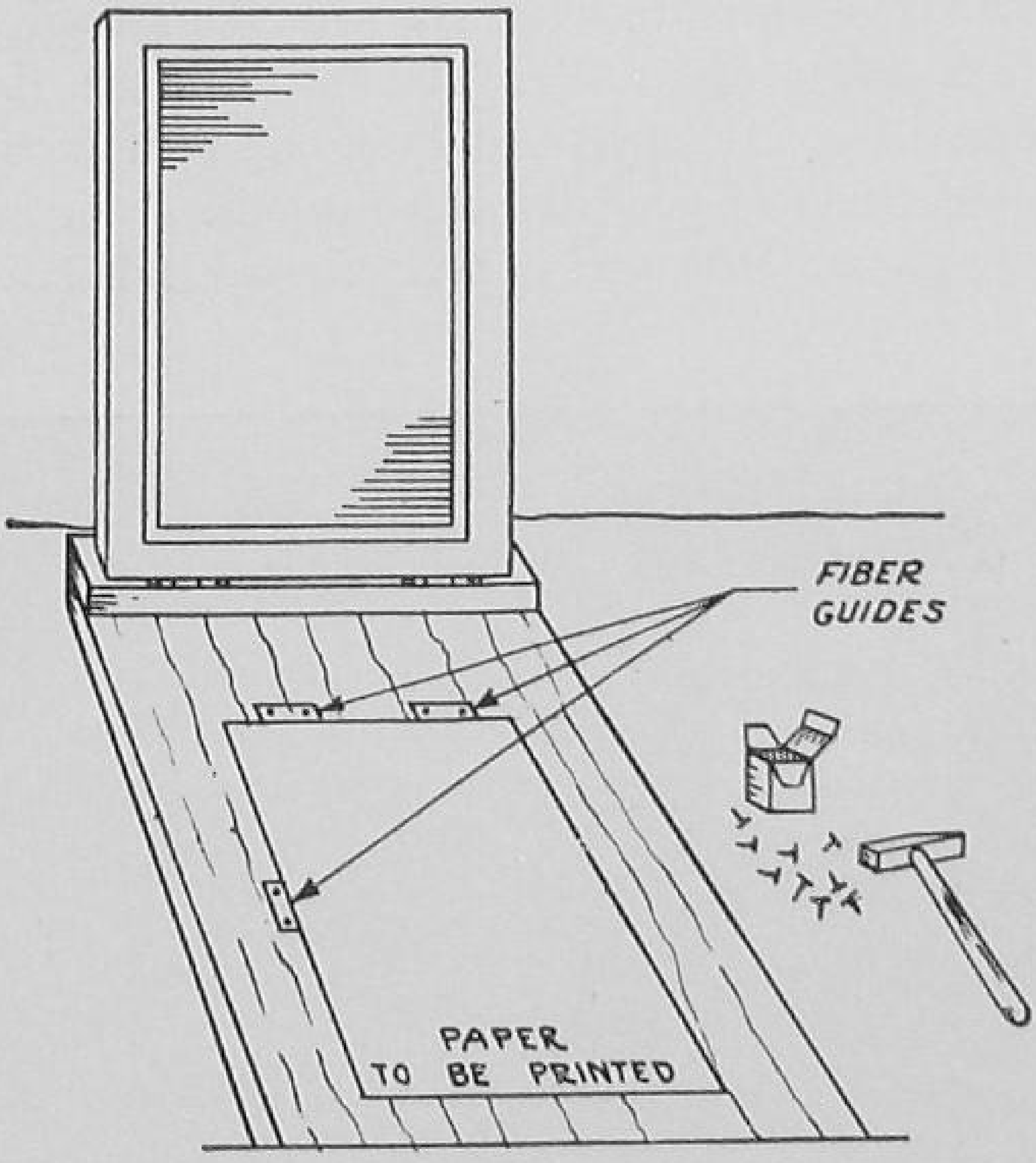


FIG. 49. Placing the guides.

with lacquer thinner and wipe both sides of the silk with it to remove any oily residue of size that may have remained in the mesh. The silk is now at its maximum receptivity for the lacquer stencil. Any neglect in cleaning it thoroughly may cause much trouble when adhering the stencil.

Fasten the frame to the base with the push-pin hinges or the wingnut bolts of the crossbar. The next step is to position the paper or card to be printed on the baseboard. If the design is to be centered on this sheet,

place the sheet on the board so that its center lies closely under the middle of the silk area when the screen is lowered upon it. Raise the screen again and place your guide stops on the baseboard, so that all the sheets may be printed in the same register. The guides may be small strips of common cardboard, about 1″ x 2″. Hard fiber board, if available, is better as it is impervious to oil and solvents. It may be attached to the base with a couple of tacks or by gluing. See Fig. 49.

Adhering the Stencil.

Lay your cut-out film stencil on the positioned card, film side up, in exactly the position you want it to print. Lower the screen on it, and check that the silk is in perfect contact with the stencil all over. Have two pads of soft cotton rags ready. The best kind are those made from men's old undershirts. Moisten one of these rags with the adhering solution which the manufacturer of your film recommends. Adhering solutions are all of a lacquer thinner base, and in their absence this latter solvent may

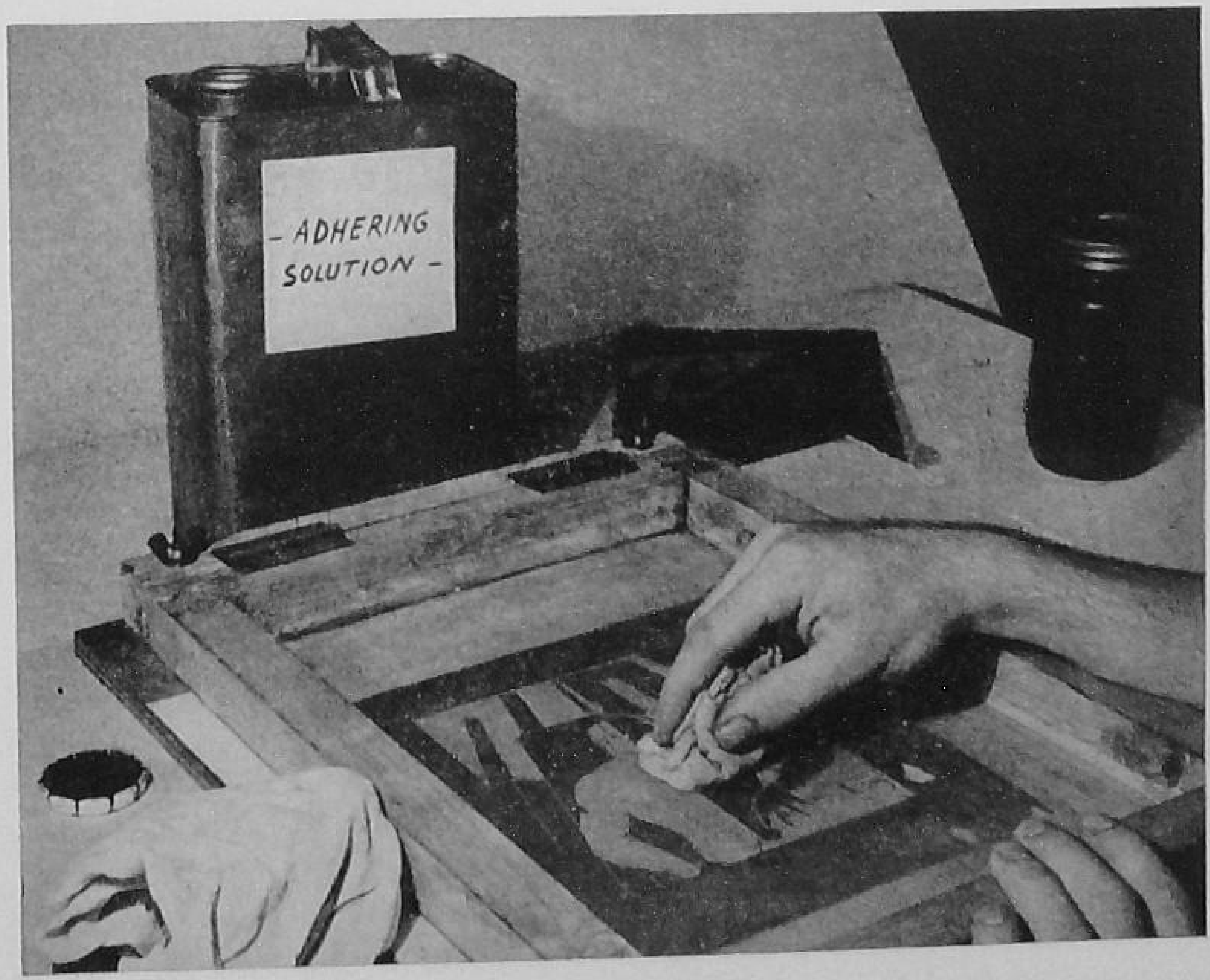


Fig. 50. Rubbing with a cloth to remove the excess thinner.

be used, provided you proceed with great caution. Lacquer thinners are not all the same, and their action on the film stencil may vary greatly. Rub the moist rag over the top of the silk with even strokes of about 5" to 6", and immediately rub the same spot briskly with the dry cloth in order to help the thinner to evaporate quickly. See Fig. 50.

The lacquer thinner in the solution softens the lacquer coating on the film, rendering it tacky, and the pressure of the brisk rubbing with the dry cloth glues the silk to it. If too much adhering solution is used, the stencil will be ruined by the thinner dissolving it along the edges. It is always possible to add more solution if too little was used in the first place, but when too much is used with a resulting dissolved stencil all the previous work is wasted.

When the edges of the stencil refuse to adhere readily, the trouble may likely be traced back to the cutting with the knife. A dull stencil-cutting knife requires more pressure for cutting. This excessive pressure embosses the knife cuts into the glassine backing, so that, when you pass your fingertips over the underside of the stencil, you can feel them as distinct eruptions. Along the edges the lacquer, which is firmly bonded to the backing, follows this curvature away from the level of the face of the stencil. In adhering, the solvent, only sparingly used, will not reach these bent-away edges. See Fig. 51.

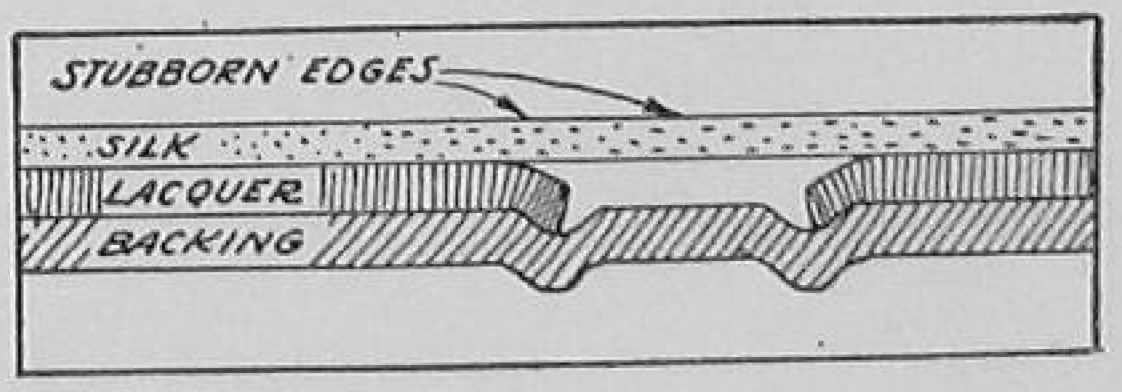


FIG. 51. Film cut with dull knife has bent edges and is difficult to adhere to the silk.

They must, however, be perfectly adhered, slowly pulling them up by repeated rubbing of the silk with the solution. Do not flood the stencil with the thinner in an attempt to hasten the pulling up of such loose edges. They might dissolve instead and print raggedly.

Removing the Film Backing.

Allow the silk to dry for about 10 to 15 minutes. Then raise the screen, and with your fingernail or the point of a knife begin to loosen the glassine backing from the adhered stencil. Start in one corner and slowly peel the

backing off the whole sheet. See Fig. 52. Stand so that you can see the film well all during this operation, and watch closely for any spots where the lacquer may show a tendency of leaving the silk. Such improperly adhered portions must be moistened again from the front of the silk and pressed down and dried. Some film manufacturers make a special stripping solution that dissolves the bond between the lacquer and the backing and facilitates this stripping operation greatly. This solution is simply poured on the silk after adhering, and in about one minute the backing will come off quite easily.

Examine your stencil closely. If any of the adhesive binder has transferred from the backing paper onto the silk mesh, plugging the latter, wash it off with turpentine or kerosene or your stripping solution.

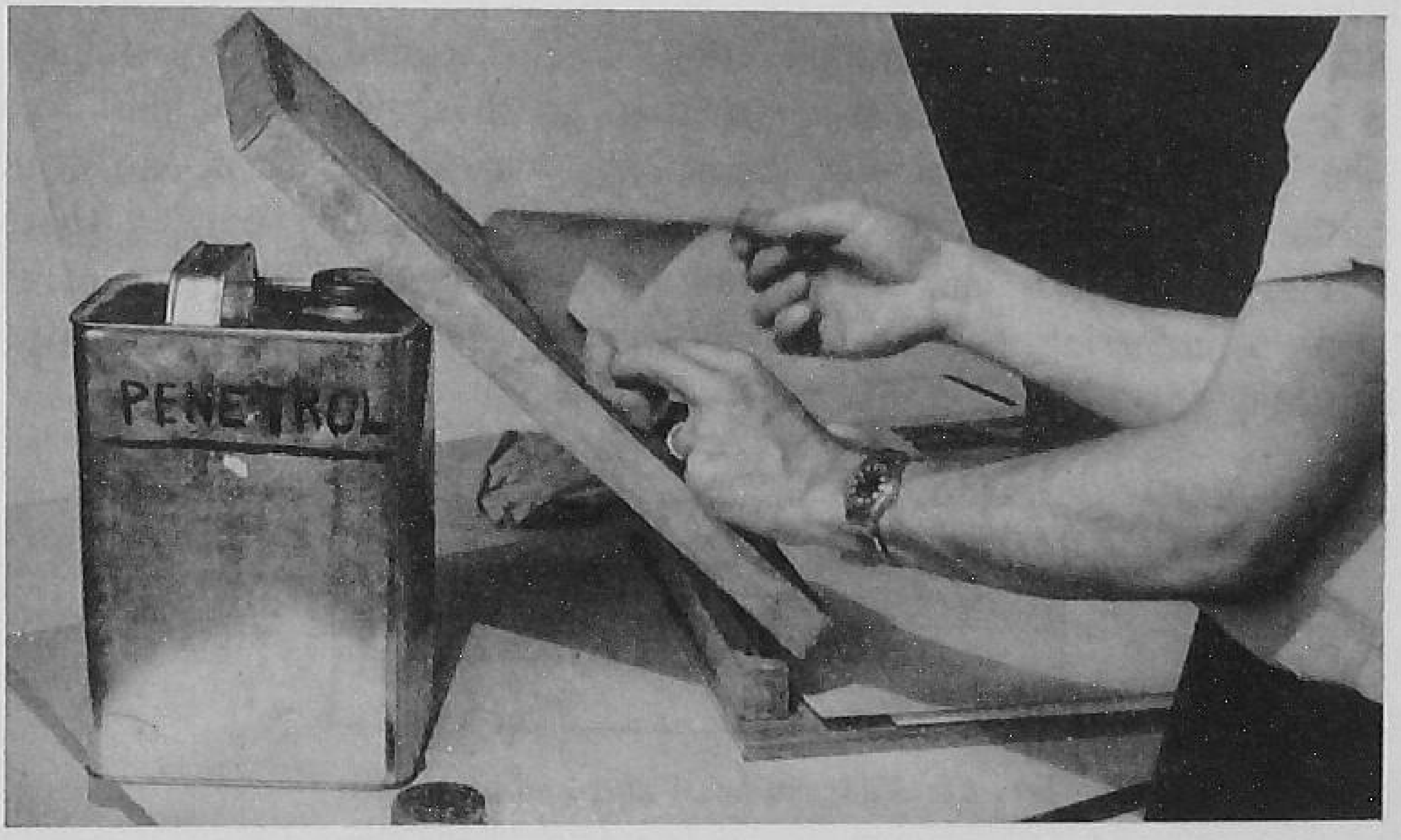


FIG. 52. Removing the film backing.

Blanking Out the Screen.

As the stencil may not fill the entire area of the screen, we shall have to close the mesh of the silk in all parts outside the design. This may be done by painting the whole area with lacquer, drying and applying a second light coat of the same material over any pinholes that still show when the screen is held up to the light. Or it may also be done by gluing paper over the whole screen area with a frisket window cut out for the design on the stencil. See Fig. 53.

In order to prevent the paint from seeping through from under the edges of the wooden frame and onto the prints and the baseboard, paste strips of gummed paper tape around the basin side of the screen; fold the tape lengthwise in the shape of a strip of angle iron and paste one half on the silk and the other on the wood of the frame. When dry, coat the tape with lacquer, shellac or glue to make it still further leakproof.

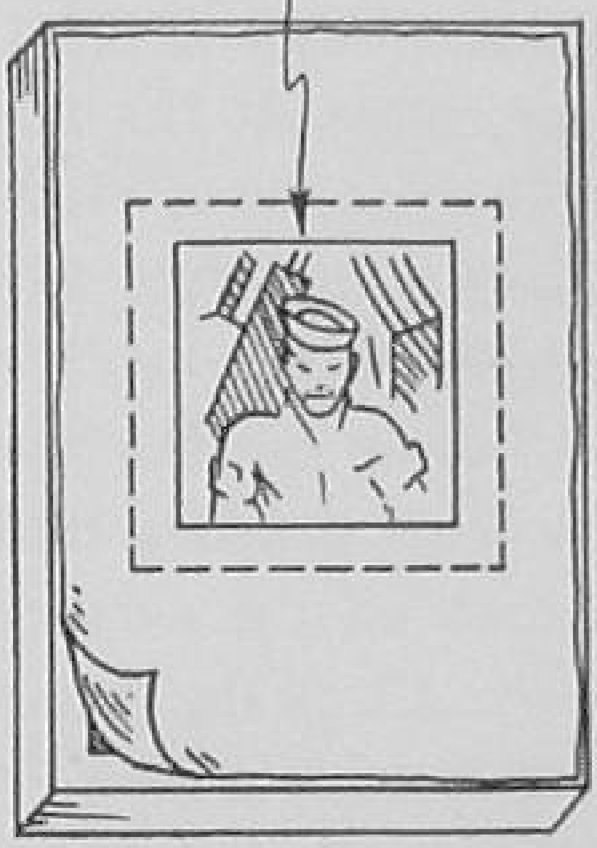


FIG. 53. Paper frisket over open-mesh silk areas pasted on underside of screen.

The film stencil is now ready for printing. This operation is described under a later separate heading, as it is the same for all stencils, no matter how they were made.

Removing the Film Stencil.

When printing is completed take a stiff piece of cardboard and with it lift the remainder of the paint paste from the basin of the screen. Wash the entire screen with several cloths and kerosene or turpentine, until all the mesh is quite open. If you want to keep your silk in good shape, do this cleaning as soon after printing the last print as you can. Dried paint in the mesh of the silk is hard to get out again and may ruin your screen material long before its normal time.

The frame with the stencil may be stored for later use. If you are quite sure you do not want it any longer, the stencil is dissolved with lacquer thinner, and the screen becomes available for another job. Lay several thicknesses of newspaper under the stencil, lower the screen on them, and place an old towel soaked with lacquer thinner in the well of the frame. Let the thinner act on the stencil for about 10 to 15 minutes. At the end of this time, raise the screen and you will find the stencil has left the silk and adhered to the newspaper, where it has not been completely dissolved. Wash both sides of the silk with the thinner and rub it dry with a soft dry rag. Your screen is as good as new again. The outlines of the shapes just printed will still be visible in a dim tint of the color employed; but this is merely a discoloration of the silk strands, and does not impair in any way the screen's usefulness for a new printing job.

Multicolor Film Stencils.

For the sake of simplicity of presentation we have, so far, considered the stencil as a complete one in itself; that is, of a design to be printed in one color only. However, the hobbyist will soon want to make multicolor prints. To satisfy this ambition he will have to cut a separate stencil for each color, and print all the sheets of his edition as many times as there are colors in the design. The complete picture-copy should be made in full color, on a card the same size as those on which it is to be printed. Such a complete working drawing provides a foolproof method of color registration.

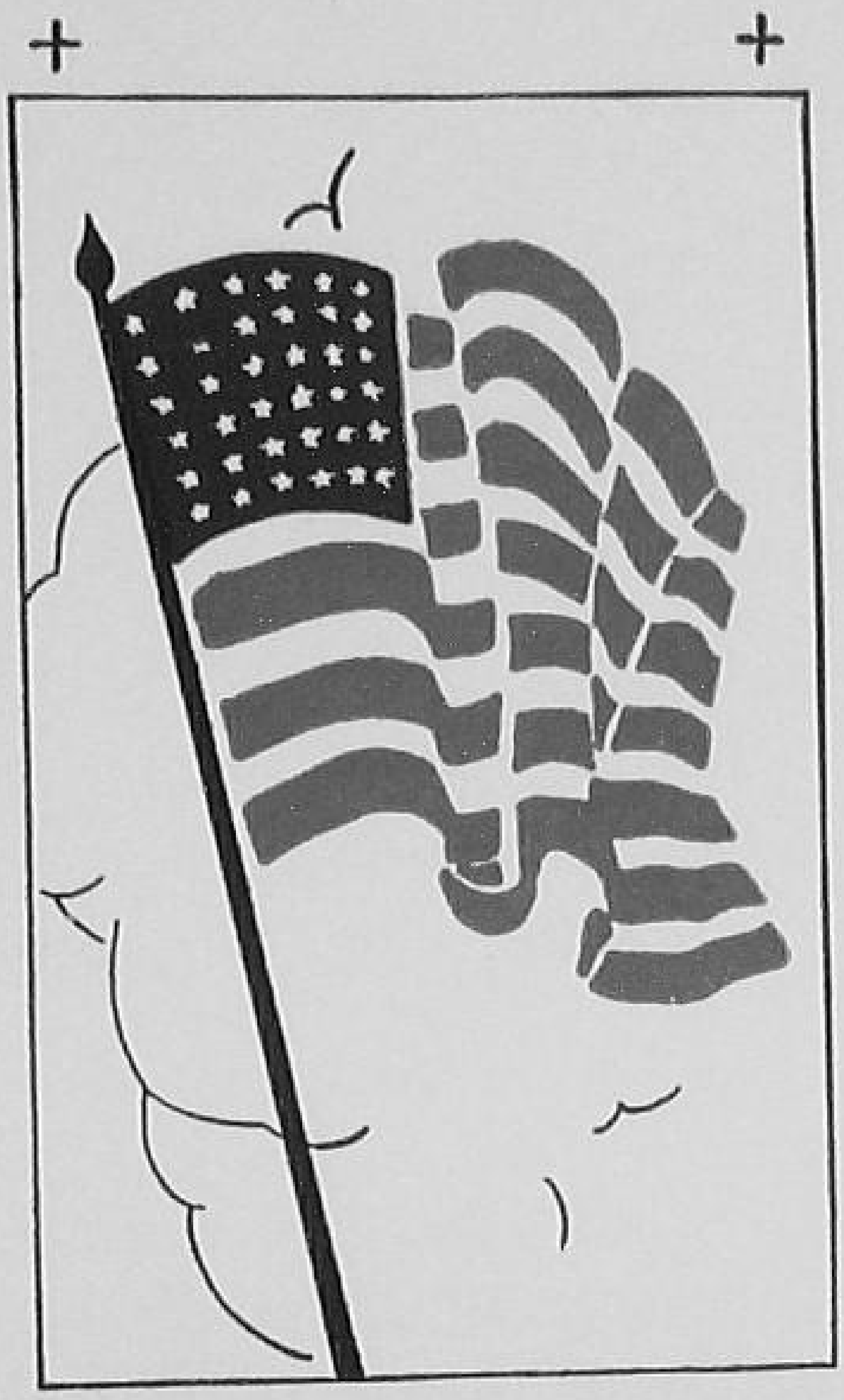
Before cutting the stencil for the first color to be printed, center the working drawing under the screen and nail down the guide stops, against which all the cards will later be placed for each of the successive printings. Place the film sheet for the first color stencil on the drawing, fastening it with a small piece of Scotch tape at each corner. Cut and strip all areas that show in the color for which the stencil is intended. To adhere the stencil, place the drawing with the cut stencil still attached in the register guides, and adhere the lacquer as was explained above. When you raise the screen, the drawing will be lifted along with the stencil. Insert a thin knife between the two and cut the Scotch tape. Then remove the backing paper, blank out the rest of the screen, and print your first color. Follow this same procedure for each of the succeeding colors, and you will find that the flat color areas will fall into exact register like the pieces of a jigsaw puzzle.

Color Register.

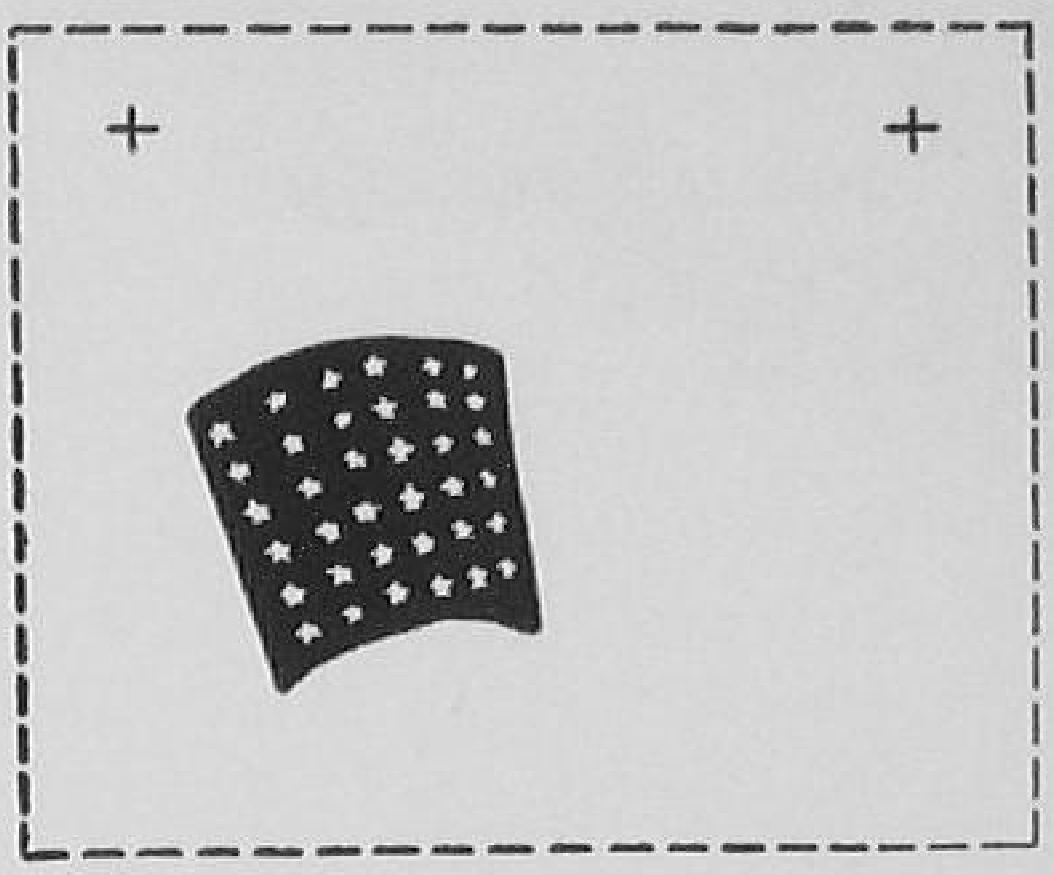
If you prefer cutting all your stencils before printing, you should draw two fine crosses at both the right and left upper corners of your working drawing. Cut these lines as single knife cuts into each stencil, so that you may later replace each stencil back on the drawing again in exactly the same position, by simply registering these crosses. See Fig. 53*A*.

The type of paint you are going to use may have an influence on the way you cut your color stencils. Transparent paints, when superimposed one over another, combine to make various additional colors and this possible effect should be taken into consideration when making your color separation on the original drawing.

When the use of only opaque paints is planned, you should provide for a very slight overlapping of the edges along which the color areas meet, so as to avoid all white gaps between them. Whenever a black outline

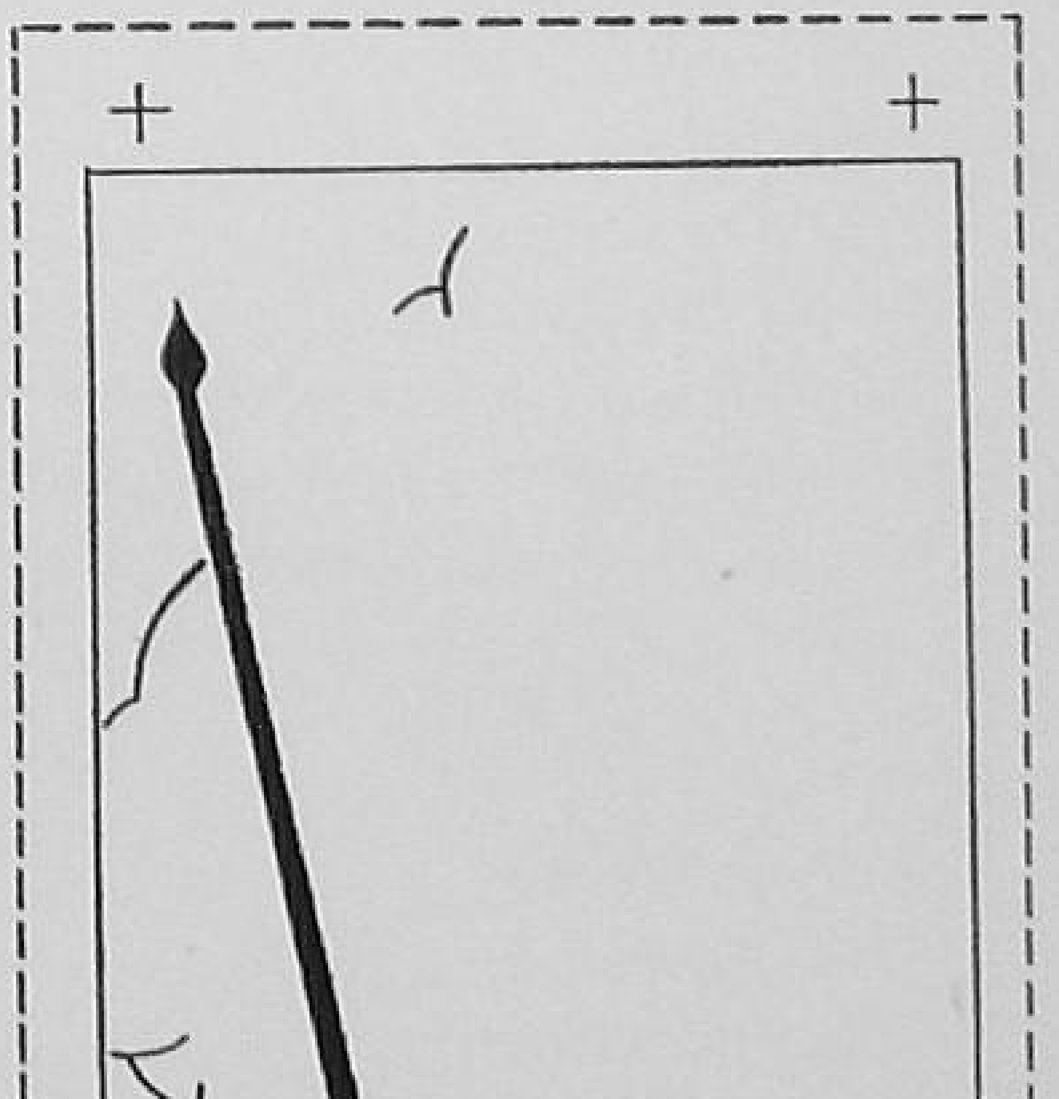


Working drawing in color with register marks.



Blue Stencil with same register marks.

Red Stencil with same register marks.



Black Stencil with same register marks.

FIG. 53A. Method of Registering Multicolor Film Stencils.
All bear same register marks as original drawing. Stencils need only be large enough to cover individual color areas.

drawing is to be printed over the color joints, each color should be made to extend to the middle of this black line, which will be printed last and will straddle the lines of contact.

The Blocking-out Stencil Method

In the block-out stencil-making method the lacquer, instead of being cut on a dried sheet, is simply painted on the screen in liquid form with a brush over the fabric areas in which the mesh must be closed.

Tracing on the Silk.

Place the original drawing on the base under the silk, and trace all the outlines of the printing areas with a finely sharpened pencil. The silk is quite transparent and all lines are clearly visible through it. A medium pencil is best so that little pressure need be exerted to make a visible line on the silk. Trace in clean, neat lines.

Masking Out with Lacquer.

Remove the frame from its base and prop it up slightly for convenient painting. Do not stand it vertically, as the lacquer might run into the open mesh parts. With a fine brush and a good grade of lacquer, paint in the outlines and small areas of the design. Follow the outside edges of the design, as you will want the printing areas to completely extend to the traced lines.

Lacquer so applied will dry hard in about twenty minutes. To make your work easier to control, you may color your lacquer by adding to it a very small quantity of black or colored drawing ink.

The Sized Lacquer Stencil.

If you find it difficult to obtain sharp edges with the lacquer you may, on your next stencil of this kind, size the silk with glue before painting on the lacquer. The mesh count of the silk on your screen and the quality of the lacquer you are working with will determine whether or not sizing your screen is necessary.

When decided upon, make a thinned solution of glue and water, and brush the entire inside of the screen with it, over the pencil tracing. Then paint in the lacquer as above, over all the areas that are not to print. If your prefer working without a tracing, you may do so. Simply lay your glue-sized screen over the original drawing and follow its outlines with the

lacquer. The glue leaves the silk transparent enough for visibility, yet renders it impervious to the lacquer so it cannot soil your original. On this sized screen you will find the brush-work much easier than on the raw silk and the edges of your design will be more sharply outlined.

When the lacquer has completely dried, remove the frame again and with a sponge or soft rag and warm water dissolve the glue, from the basin side of the screen, in all the areas where there is no lacquer. Do not wet the underside of the frame. You might dissolve the glue layer between the lacquer and the silk in the blocked-out spaces, and the lacquer might blister.

Glue Stencils.

If no lacquer is available, pure shellac will do for the same purpose, but it is more difficult to clean the screen well after printing. The shellac particles embed themselves into the mesh of the silk, and you may have to resort to scrubbing.

Another substitute for lacquer is thinned glue, the same as described in the preceding paragraphs for sizing. It takes considerably longer to dry, and cannot, of course, be used when the printing is to be done with water colors. The moisture in the tempera or water colors would dissolve your stencil during printing. For printing with oil-process colors Le Page's full-strength glue may be used for blocking-out stencils, after it has been thinned out with about two parts of water to one part of glue.

Check your screen for pinholes in the glue stencil before attaching it back to the base. Any discontinuities in the stencil must be repaired by applying more glue.

Solvents.

After printing is completed, the glue stencil is simply washed off the screen with warm water. Alcohol must be used as a solvent for the shellac stencil, and lacquer thinner for removing those blocked out with lacquer. Use the same solvents to clean your brushes.

Color Block-Out Stencils.

Prints with multiple colors can easily be made with this method, if the precaution is taken to trace each succeeding color outline from the same original drawing, placed accurately each time against the same fixed guide stops. However, if the frame has ever so little play in its hinges, it may not always fall on the guides in exactly the same position. Therefore make

sure that the hinges of your printing frame are firmly fastened, and that there is no loose play in their pins. All the sheets to be printed must be fed to the same guides for each color.

The Tusche-Glue Stencil-Making Method

The tusche-glue stencilling method is the one favored by the fine arts serigrapher, although it is by no means limited to art prints. It is the method best adapted for making many stencils in different colors that are all to be run in relatively small editions. The serigraphs on exhibition in art museums are all run in from ten to sometimes as many as thirty colors. The tusche-glue method, being a paint-on process, is the one most handy to the artist trained in brush and crayon work. It allows shading and textural effects not possible in the other stencil-making procedures; and it is quite inexpensive.

Lithographic Tusche.

The name of the method is simply derived from the material employed to do the drawing on the silk. This is lithographic tusche, a greasy substance made in solid crayon form or in liquid form to be applied with a brush or a pen. Waxes, oils and soap form its base. Lampblack is added to make it more visible, so the artist may observe the progress of his work. It is also available in the shape of pencils, the core being the crayon in merely another shape. The covering is of many windings of paper, and the tusche is well protected by it. In many instances the lithographic pencil is handier than the other forms of tusche. In the trade they are often called Korn pencils.

Tusche in any form is readily soluble in kerosene or turpentine. The solid forms are water-repellent, and the liquid becomes so upon drying. Upon these properties of tusche rests its usefulness for our present purpose.

The Tusche Drawing.

Have the original drawing in color on a card the size of those on which the printing is to be done. Center this working drawing under the silk and attach your register guides to the base of your frame. With pencil, outline on the silk all the lines and areas that are to be printed in the first color. Remove the screen and lay it flat on a padding of a few sheets of old newspaper. If you use the liquid tusche it should just flow evenly from your brush or pen, without any running or spreading. If it is too thin, leave the bottle uncorked until the water content has sufficiently evaporated to

leave the tusche in just the right consistency. If too stiff, do the opposite: add a very little water. Shake the bottle well each time you begin working with it. Paint the tusche on the silk with an artist's water-color brush of suitable size, covering all the printing areas with it. This is the reverse procedure from the one followed in the previous stencil-making method. There—if we may borrow a term from photography—we made a negative with the colored lacquer. Here we are making a positive with the tusche. While still wet, the tusche can be washed off with water; once dried it takes kerosene or turpentine to correct an error.

When all the parts that are to print in the first color have been painted in, let the tusche well dry. When using crayon or pencil tusche, work as you would with ordinary drawing materials of the same type. With them you may obtain shading effects and fading tones that no other stencil except the photographic one is capable of rendering.

Gluing the Tusche Stencil.

Raise the screen slightly from the table surface by inserting two thin strips of wood under it. Dilute Le Page's liquid glue with two parts of water and stir well. Pour a little of this mixture on the silk, and with a stiff cardboard used like a squeegee, distribute the glue over the entire surface of the silk. Squeegee it over the drawing as well as the open mesh of the silk and let dry. A very few drops of glycerine added to the glue mixture will make it more flexible and prevent its cracking when the drying is done in a dry, artificially heated atmosphere. While drying, keep the frame in a horizontal position, as the glue would otherwise run and dry in streaks.

When completely dry, repeat the whole gluing-in operation once more in the same fashion. Do not skip this second gluing, even if your screen does show no pinholes. After drying, examine the screen carefully against a strong light to discover any pinholes that would let the paint through and smudge your prints. If you find any, patch them immediately with full-strength glue. Dry again, and your stencil is ready to be washed out.

Washing out the Tusche.

The mesh of all the silk is now closed with the glue. That of the printing areas has on it the dried tusche and the glue covering. In these latter spaces we shall now dissolve the tusche with solvent that will have no effect upon the glue covering the masked-out spaces. As the dissolved tusche leaves the printing areas, it will carry with it the thin film of glue over it,

which was not bonded to the silk, the tusche being in its way. Thus the mesh of the screen will be opened and will allow a free passage to the paint in printing.

The solvent we shall use is a half-and-half mixture of benzine and kerosene. With the frame lying flat on some old newspapers, pour a liberal dash of the solvent on the silk and distribute it with a cloth. Soak the rag well and also rub the underside of the screen. After a few minutes the tusche drawing will begin to break up here and there, carrying the glue covering with it. However, in most cases there will be some stubborn parts which refuse to dissolve with ordinary rubbing. They will require a gentle scrubbing with a nailbrush or on old toothbrush and solvent.

When the mesh of all the printing parts is finally opened, dry the screen by rubbing it gently with dry, soft rags, and the stencil is now ready for printing.

Cornstarch Sizing for Fine Linework.

In our examination of screen fabric materials we have noted that silk comes in a variety of meshes. For all ordinary work we have used #8 or #10 mesh. You may find this too coarse for work that contains very fine lines or lettering, cross-hatching, ruling pen work, or intricate, delicate brush work. In that case #14 or #16 mesh silk should be obtained, and the silk, after removing the commercial size, should be sized before drawing on it with a cornstarch sizing of your own making. This sizing will provide a smoother drawing surface for the tusche work whether applied with extra-fine brushes, pen, or well-sharpened litho pencils.

To make the sizing, mix a heaping tablespoonful of ordinary household cornstarch with a tumblerful of warm water. Stir this until the water is of a milky white appearance and no loose starch is floating on it. Make your pencil tracing on the silk and then apply the sizing mixture evenly to the drawing side of the silk with either a sponge, a soft brush or a rag. Let the silk dry naturally.

From here on, the technique is pursued exactly as given above. The starch will wash away with the tusche in the printing parts and leave the fine mesh open for the passage of the paint. The fine linework or lettering will print considerably sharper than it would without the sizing.

Removing the Tusche Stencil.

After printing is completed and all the paint washed off the silk, the glue stencil is simply washed off the screen with a sponge and warm water.

Wet both sides of the silk fabric. If the glue is stubborn, spread a wet cloth inside the frame and let the glue soften before wiping hard. Unnecessary scrubbing wears the silk and shortens its life.

Special Effects.

Lithographic pencils come in varying degrees of hardness. Shading effects can be achieved with them by using different pencils or by varying the pressure exerted with them. Still other quite effective imitations of textures are possible by placing various materials under the silk while shading with the crayons or pencils. Grained leathers, hard linens and cloth of different weaves, burlap, sandpaper in different degrees of coarseness, wood blocks of various grain formations, will all provide textural changes which, when judicially used, enhance the expressiveness of your prints no end.

With the liquid tusche, similarly, you may achieve spatter effects, dry-brush imitations, and shadings by using hard bristle brushes or toothbrushes. Charge the bristles with the tusche and then snap them with your fingernail or the edge of a stiff card, directing the splashes where you need them. Until you are quite sure of your ability to control the spatter it might be well to cut a paper frisket with an opening for the spaces to be spattered in this manner.

The Photographic Stencil-Making Method

The term "photographic" might be misleading. No camera or darkroom are required for making stencils in this technique. All that the amateur operator borrows from the field of photography is the principle of rendering gelatine sensitive to light by coating it with bichromate of ammonia or potassium. When this sensitized gelatine is exposed to light the gelatine hardens and becomes insoluble in hot water. Where the opaque lines of the drawing prevent the light rays from reaching the gelatine, the gelatine retains its solubility in water. On the basis of this principle we can control the areas we want to retain and those we simply wash away.

Materials.

The process of making photographic silk screen stencils has only recently been developed to a stage that makes it available to the amateur artist. Manufacturers are offering special film sheets and solutions for

rendering them light sensitive. They all claim foolproof reliability and simplicity of handling.

One set of this simplified material and its manipulation are here described as an exploration of the field rather than as a rigid procedure. The student who intends to make photo stencils will have to get all his materials from one manufacturer with a set of specific instructions governing their use. The materials here described are sold under the trade name of Fotetch Film method.

The Transparent Positive.

Photo stencils permit the printing of the very finest lines and dots, close shadings, and even handwriting. The copy must be made in opaque black ink on a transparent medium, such as celluloid or tracing paper, in the exact size it is to be printed. Drawings and lettering or printing may of course be photographed with a camera and a transparent positive made from the negative. Ordinary snapshots and portraits, however, cannot be used for such copy unless they be broken up into halftone dots by being photographed through a screen in a photo-engraver's process camera. Much of this work is done today, but it is beyond the scope of craftwork and requires highly skilled training and expensive equipment. The amateur will have to limit himself to those subjects that he himself can draw, letter or write.

Sensitizing the Film.

The gelatine film is sold by the dealer unsensitized. It has to be used up within a few weeks, as the material deteriorates after that time. The sensitizer, a bichromate solution, is also perishable. Therefore, do not stock up any large quantities of either. The film is sold in sheets 20" x 36"; the smallest bottle of sensitizer contains 4 ounces. The two together cost about $2.50.

Cut a piece of the film slightly larger than your drawing and fasten it down on a clean sheet of glass with Scotch tape around the four edges. Brush the bichromate solution on it with a soft camel's hair brush, spreading it well in every direction. As the sensitizer dries, the film becomes sensitive to light, so the painted film should be put to dry in a dark place. The film is then ready for exposure.

Exposing the Film.

If you have a large enough contact frame of the type used for printing contact photos or the ones used for printing blueprints, place the trans-

parent positive drawing face up on the glass and lay the film with the sensitized side against it. Insert the back pad and close the frame.

In the absence of a frame leave the film flat on the glass slab and place your drawing face down upon it. Lay another heavy plate of glass over this, choosing it large enough so the ends extend a good bit beyond the film visible through it. Put some heavy weights, like two large books, on these two ends to weight down the top glass and press it tightly against the drawing. See Fig. 53*A*. These operations have to be done in subdued light.

For a small piece of film only, that is, up to the size of a letterhead, fix a 300- or 400-watt or a #2 photoflood bulb in a reflector at about 15″ to 18″ directly over the printing assembly. Turn the current on and expose for about 2 minutes. No foolproof exposure time can be given. It varies with the intensity of the light as well as the degree of transparency of the drawing, not to mention again that various films and sensitizers require different individual exposure techniques. Make a trial exposure of your drawing with parts blanked out to exposures of a 30 second step-up each, keeping accurate records. Upon developing, you will be able to determine which is the correct time for your transparency and other factors. In this way you will soon acquire a working knowledge of your materials.

Developing the Film.

After the exposure, the film is placed in a tray of water whose temperature is about 100 degrees F. As soon as the film is wet, the tray can be taken to the full light, which will no longer affect the sensitized gelatine. Rock the tray or use a soft tuft of cotton to rub gently over the surface of the film, and after a few minutes you will see the gelatine dissolve in the lines of the design. In the parts where the light rays have penetrated through the transparency of the drawing to the gelatine, the gelatine has hardened and will not be affected by the hot water.

Running hot water of the right temperature is, of course, better, as you will not be hampered in your observations by the discoloration of the water. In a tray, this inconvenience can be overcome by changing the water a few times during the developing. If the water is too hot the hardened gelatine may be affected and dissolved in narrow spaces between two open lines.

As soon as the lines are all clearly open, remove the film from the hot water. Replace the hot water with cold water. Leave the film in the cold water to fix it while you prepare to adhere the film to the silk.

Adhering the Photo Stencil.

Spread the wet film on one of the cards on which the design is to be printed and place this card in the guides of your printing frame. Lower the screen upon the wet film and press down quite firmly from the basin side of the silk. Place a newspaper in the frame and with it soak up the excess water as it is squeezed through the silk. Repeat this until all the moisture has been taken up. Then lay a flat weight on the silk to keep it in tight contact with the film while the film and the silk are left to dry. When completely dry, raise the screen and strip the backing paper of the film material away from the adhered stencil. The gelatine emulsion will be tightly adhered to the screen, forming a perfect stencil that can be saved and stored after printing.

To remove the stencil from the silk, soak the stencil by placing a wet cloth both under and over the silk and letting stand a short time. The gelatine emulsion will soften and then can be easily peeled off the screen material.

Printing Procedure

The description of the actual printing process has been delayed so far because it takes no account of how the stencil was made. It is the same for all stencils, made by any of the five methods discussed. Its particular problems are the selection of the proper paints for the surfaces to be printed upon and their manipulation for best results.

Process Paints.

The most commonly used printing medium is paint made from finely ground pigments mixed with an oil-base vehicle. Manufacturers put them up in cans of various sizes in the right paste consistency for use. The prices vary slightly for individual colors—purple, emerald green and certain reds are more expensive; black and white are cheaper than the other colors. Paints come in many shades and may, of course, be mixed to produce many more.

The points to consider when buying process paints are strength of pigments, uniformity of shade, permanency, dull or gloss finish, and drying qualities. Each manufacturer puts out a variety of paints for special purposes, such as printing on metal, glass, canvas. Each also offers in connection with his paints a series of reducing, extending and other "doctoring" media. If your art store has no complete literature to give you, do not hesitate to write to the manufacturer whose address appears on the

label of your paint cans. They are all eager to tell you the whole story of the paints you are using, and how to get the best results with them.

Process water-color paints are also available, if you desire the soft mat effect of a tempera or water-color paint for your prints. They are generally cheaper than the oil paints, the pigments being ground in less expensive glycerine and gums. They also dry faster and, being translucent, allow you to obtain additional tones on your print by overprinting. They are, however, not as permanent as the oil colors. Remember also that they cannot be used with the water-soluble glue stencils.

The Squeegee.

To take an impression, the paint is forced through the screen with a special tool called the "squeegee." It is constructed like a window-washer's squeegee or the windshield wiper blade of your car: a grooved holder with a rubber blade inserted. See Fig. 54.

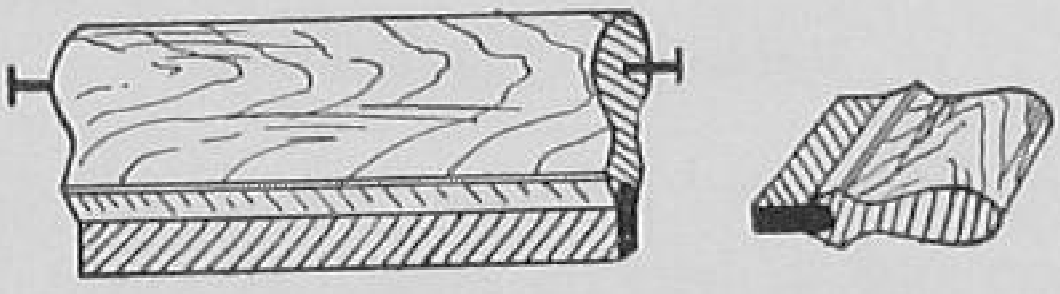


FIG. 54. A printing squeegee.

The rubber must be fairly stiff and able to withstand the softening action of the varnishes and oils contained in the paints and solvents. Natural rubber is not as good in this respect as the newer synthetic product. Although rubber and the grooved wood can be bought to make your own squeegees, the saving is almost insignificant. Squeegees sell completely assembled for about ten cents a running lineal inch. The blade extends from the handle about 1¼", just enough for convenient resiliency, yet no easy give. It is cut and ground square at the bottom. In use, pull it over the screen at an angle of about 60 degrees from the screen, so that only one sharp edge of the square bottom is in actual contact with the silk. It pushes the whole supply of paint in the basin from one end of the screen to the other, forcing it evenly through the open mesh parts. If the squeegee is held in too vertical a position the impression will lack color; if it is held too flat the paint will not evenly scrape and may be lumpy in parts, the outlines becoming ragged.

The length of the squeegee should be somewhere between the inside width of the frame and the widest width of the stencil. It should allow

for the printing of the whole stencil in one sweep. Sectional squeegee work with a tool too narrow results almost always in streaky printing.

A nail driven in each end of the wooden holder will make a convenient stop to rest the squeegee against the printing frame. This will prevent its falling into the paint basin of the screen and becoming soiled.

Sharpening a Squeegee.

A good squeegee will last for many thousands of clear impressions if properly taken care of. If, after long use, the sharp printing edges of the blade become worn and slightly rounded from repeated rubbing over the silk, the blade may be resharpened over a sheet of medium-fine sand-

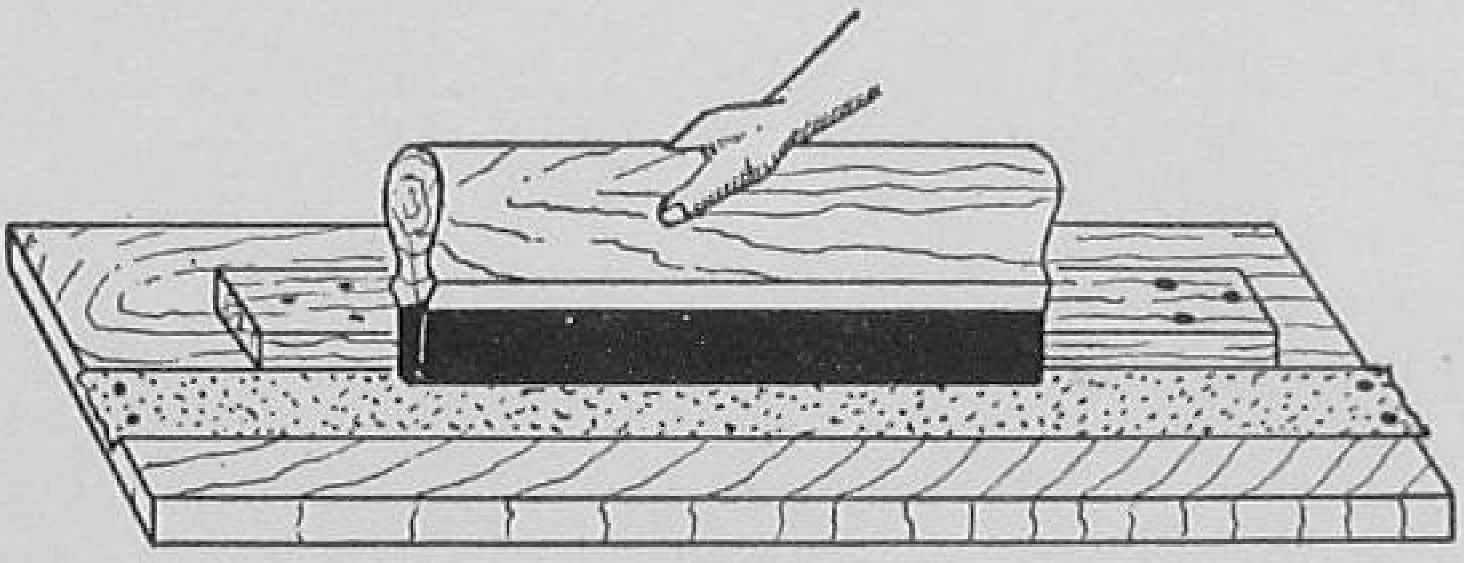


FIG. 55. Sharpening a squeegee blade wtih sandpaper.

paper. See Fig. 55. Be sure to hold the blade perfectly vertical, so that the new face is exactly at right angles to the body of the blade. Pass it over the sanding jig in the manner a woodworker uses his plane. Be careful not to sand the corners off unevenly.

Taking an Impression.

Lay a sheet of the paper to be printed on the baseboard of the frame and well up against the stop guides. Lower the screen over it and see that paper and silk are in even contact with one another. If the stencil does not rest firmly on the paper, you may have to slip a cardboard under the latter. Have this cardboard slightly smaller than the inside of the screen, so that no part of the frame comes to rest on it. This will raise the printing surface so that it will tightly contact the silk.

Stir your paint well so that all the oil vehicle and pigment are thoroughly mixed. Pour a liberal quantity of the mixture on the blanked out top part of the screen, arranging it over the whole width of the stencil. Place your squeegee blade in back of the paint, incline it to a 60-degree

angle, and, holding it with both hands, pull it in one continuous sweep over the whole stencil, exerting moderate, downward pressure. When the blade has cleared the nearer edge of the stencil, rest the squeegee on the frame by the two nails and raise the screen. Remove the printed sheet from the base and insert another blank one in its place, again well up against the guides. Lower the screen and push the paint backwards this time. See Fig. 56.

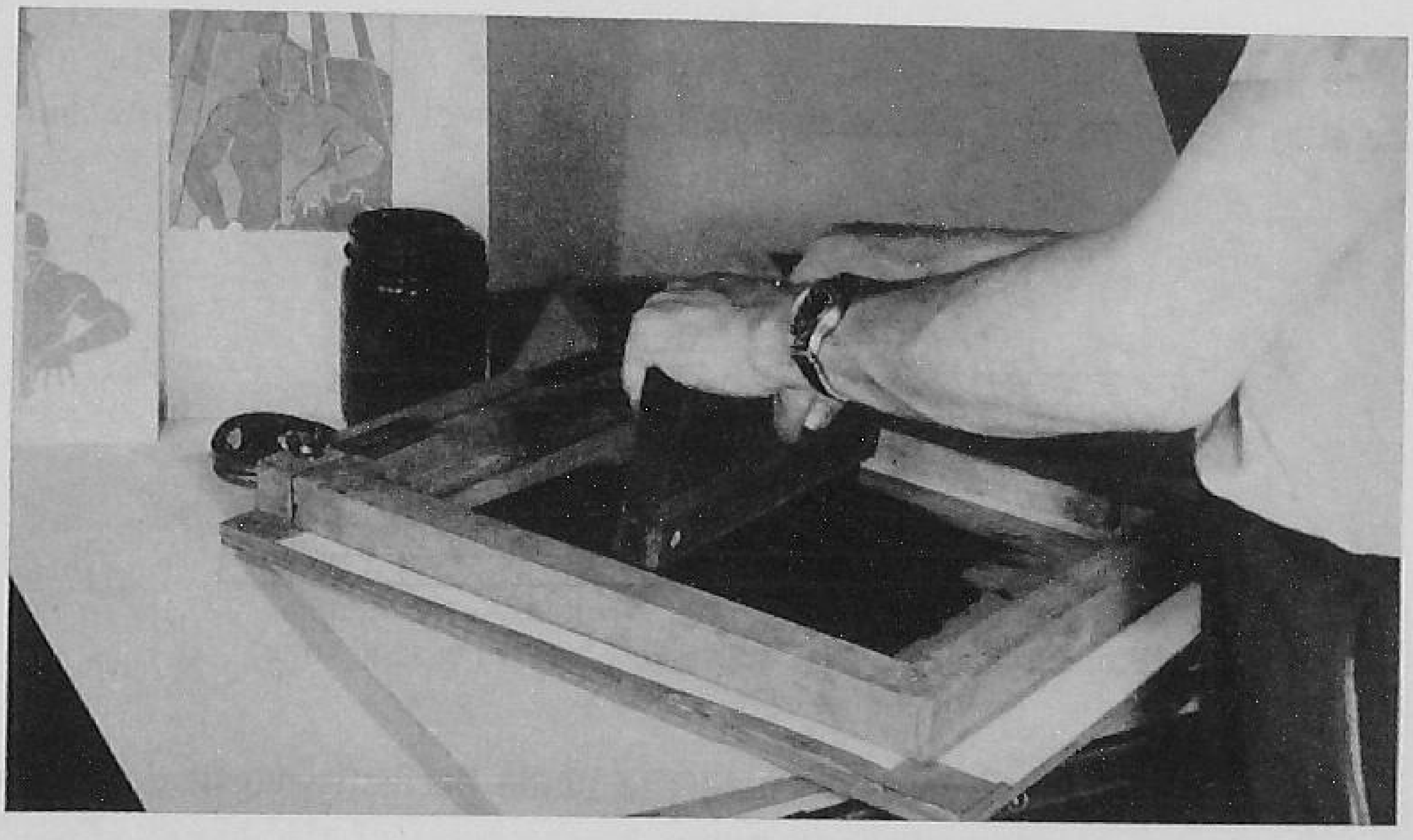


FIG. 56. Printing with the squeegee.

Repeat the above procedure for each print to be made. If after obtaining a few good prints you notice the appearance of pinholes in the solid area of the design, your screen mesh is probably clogging up or the paint is drying in spots in the mesh of the silk because it is too thick. Add a tiny quantity of No Clog Varnish or its equivalent in your make of paint to the color in the basin. If the results are not immediately improved remove all the paint and wash the mesh of the silk perfectly clear with turpentine, and then start all over again.

Drying the Prints.

The paint on the paper only partially penetrates the stock. Most of it will have to dry by the oxidizing of the oil in the air. The fresh prints should therefore be spread out on a large table or on a series of drying

boards that fit a convenient storage rack. Many prints may be stored for drying in a comparatively small space with such a rack.

The paint deposit on a print looks dry long before it really is so. Test the color with your fingernail for a sure examination. If the paint surface is hard, the prints may be stacked; otherwise, they will stick to each other and cannot be separated without tearing some of the fibers of the stock.

Thickness Adjustments.

The printing frame as we have used it so far will permit the processing of any flat material up to about ⅛" in thickness. If thicker boards, wood, blocks and toys are to be printed or decorated, the frame must be adjusted to their size by inserting a board or block of the same thickness between the hingebar and the base. Another block of similar thickness is also fastened at the opposite end of the baseboard to allow the frame to rest on it while printing. Figs. 57 and 58 show such an adjustment for decorating wooden panels and thicker square blocks or box-tops. If large box-tops are to be decorated in this manner, a block of the same thickness is inserted into the empty box to provide a firm base to meet the pressure of the squeegee.

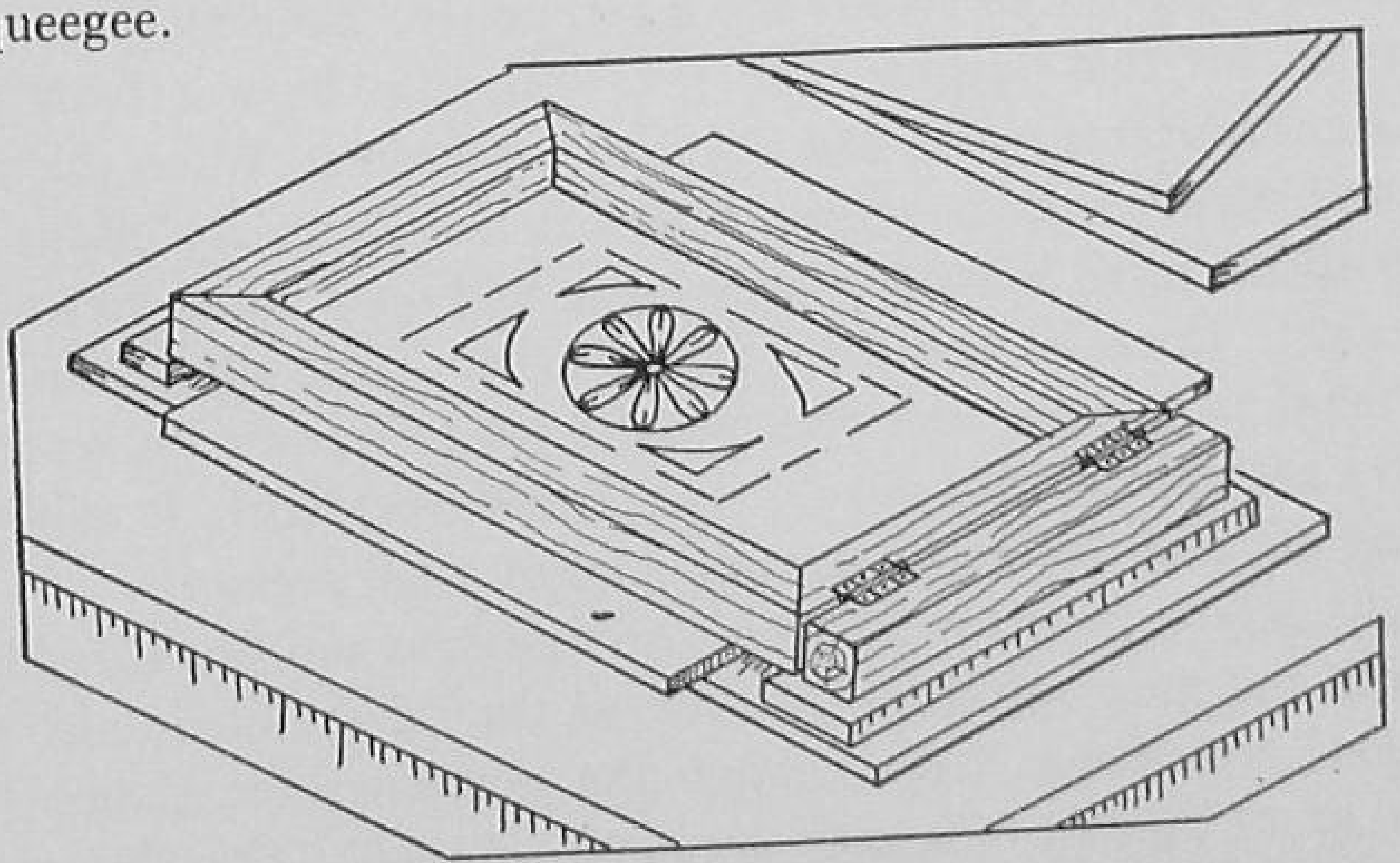


FIG. 57. Set-up of screen for printing half-inch board. Note filler strips under hinge crossbar and end of screen.

Cleaning the Printing Frame.

Prompt cleaning of the silk, as soon as printing is stopped, is of paramount importance if you expect to do trouble-free work later on with the same screen, and if you want to get all the use you can out of a sheet of silk. Within 15 minutes, at the most, after the last print remove all

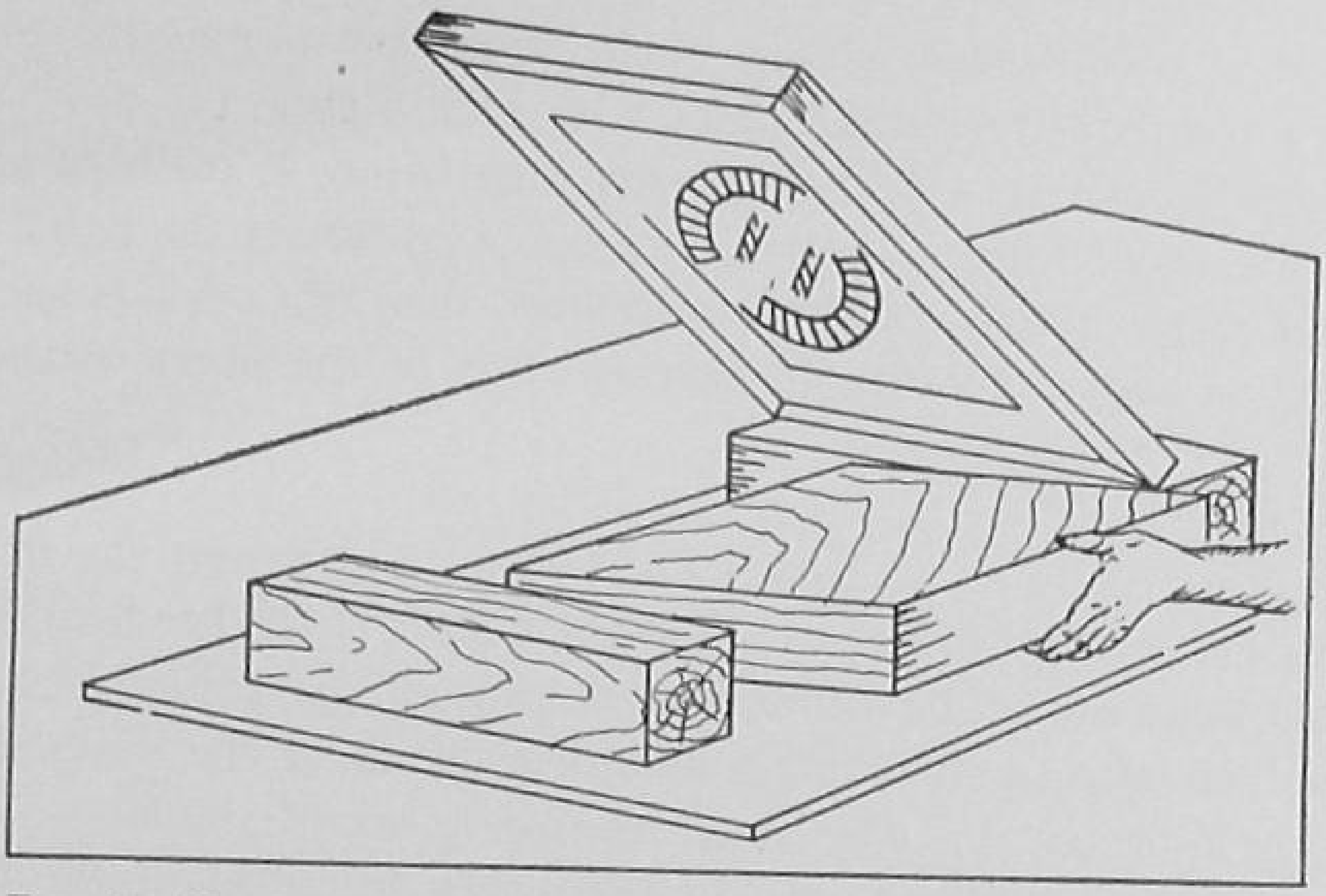


Fig. 58. Frame adjusted for printing square boxes. A solid block of the same thickness is inserted in the empty box.

excess paint with a piece of stiff cardboard from the basin of the frame, and return it to the paint can. If it is a special shade you have made up, have a screw-top glass jar handy for a receptacle. Save all glass jars from your kitchen for this purpose, and you will soon have a handy supply. Wash the entire frame, wood and all, with turpentine. Wash the silk especially from both sides of the screen, wiping it clean with dry cloths. Repeat this until all the mesh is scrupulously clean and open when viewed against a strong light. Once set and dried in the mesh of the silk, paint particles are very hard to remove, and you might have to repeatedly scrub with a brush. Do not expose your silk to such harsh treatment; it will result in its wearing out long before its normal span of good service.

Similarly, scrape all the paint from the squeegee and wash its blade and handle with the same solvents. The life of the rubber blade also depends on this good treatment. Even though the manufacturer claims that the rubber is proof against oils and varnishes, do not take this claim too literally. It is probably true enough, but it is made with the reservation that the blade will be treated with average commonsense care.

Dispose of all oily rags as soon as possible. If you cannot get them to an incinerator at once, store them in a metal safety waste can. Do not mix oily rags and waste paper in the same can or basket. They may start a fire by spontaneous combustion. Thorough cleanliness is not only neater, it is also by far safer than slovenly inattention to these "housekeeping" details. They too, are part of the craftwork.

Chapter V

BOOKBINDING

Bookbinding is one of the most interesting and pleasant of the handicrafts, and, given a fair amount of skill in handling tools, it is not difficult to learn.

Because of the opportunity it offers for the free play of fancy in decoration, as well as for exquisite nicety of workmanship, bookbinding is one of the most delightful avocations to pursue. Even if the beginner has not the ambition to emulate the achievements of the craftsmen of the golden age of the craft but feels content to bind a few volumes in serviceable cloth instead of tooled leather, he still can derive many benefits from his hobby.

It will teach him an appreciation of book construction in general, a greater respect for all well-made books, and an opportunity for the exercise of fine handwork. Fine handwork implies careful planning, reasoned foresight of a sequence of processes and choice of materials, the exercise of integrity in execution, and good judgment.

Moreover, we all know what it means to have a favorite book grow shabby and dog-eared, and how frequently we regret that it costs so much to have it rebound the way we would like it. Also, when magazines or cherished pamphlets accumulate and become a problem we would like to unite them and bind them into appropriately decorated volumes that will stack neatly in a bookcase.

The Evolution of the Book

Even a cursory knowledge of the history of a craft adds to the zest we derive from its practice. It gives our aspirations a background in time, and, in whatever small measure, it establishes a link between our own life and the lives and times of the past masters in the craft. The craftwork of a period reveals more than the outstanding skill of individuals; it is

almost as often an index to the intellectual and moral struggles and triumphs of slowly advancing civilization itself.

Modern bookmaking such as we know it today is the relatively recent culmination of the slow growth of a craft over many centuries. Its history is closely interwoven into the larger history of man's methods of recording

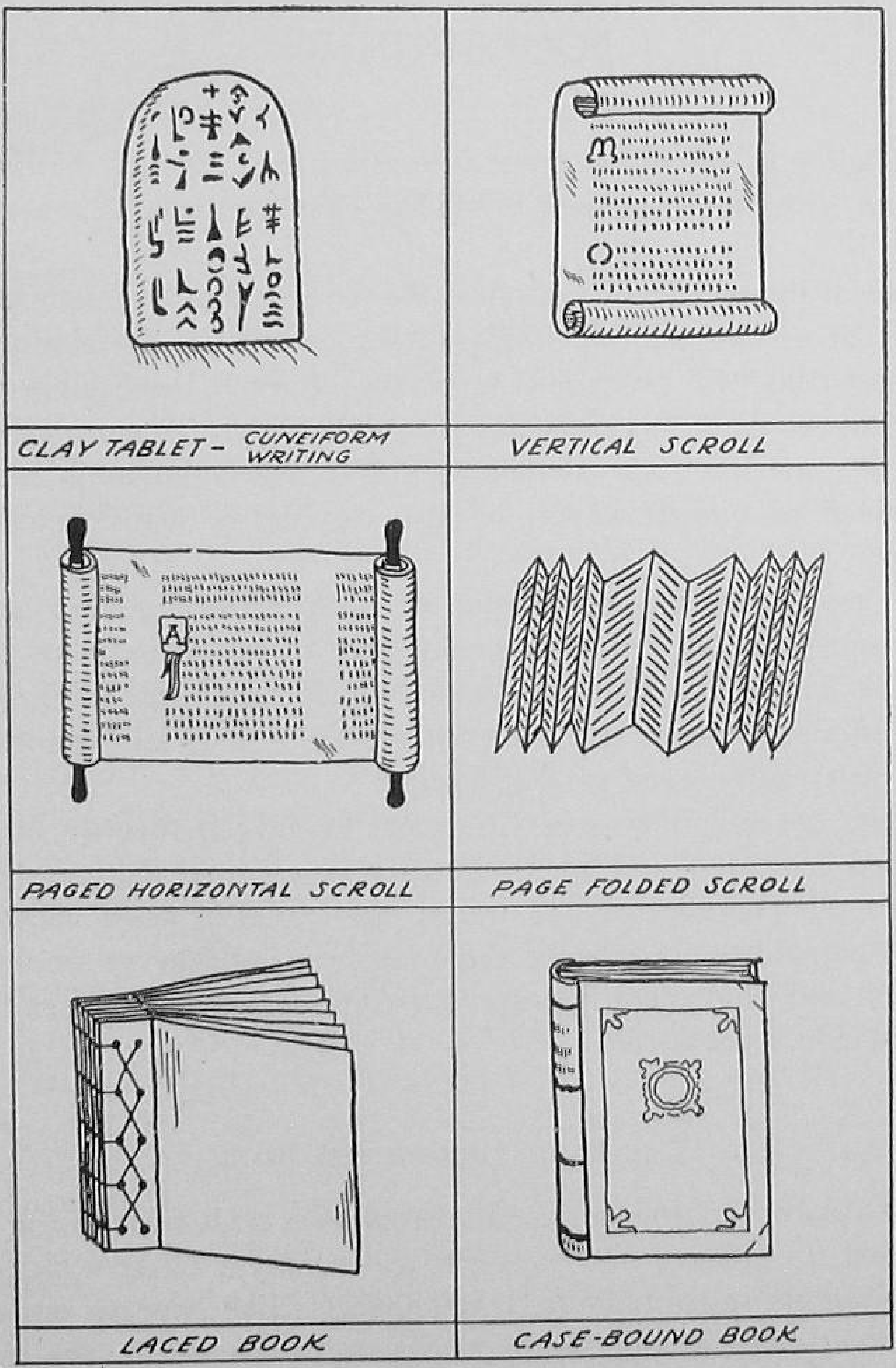


FIG. 59. The evolution of the book.

his thoughts. Many who are fairly well informed on the subject matter of early writings have hardly ever given a thought to the question of just how the ancients preserved and transmitted their ideas.

For untold centuries knowledge was passed on by word of mouth only, resulting in the traditions and legends which still form the basis of the literature of all peoples. But as man slowly grew in intelligence, he began to cast about for a more reliable and more enduring way of record keeping, and after no doubt a long time he invented writing. Clay tablets with cuneiform writings have been unearthed in the Near East. Archeologists who deciphered them place them at from 3000 to 5000 years old. They have been found frequently in large numbers together in one place. Such collections of tablets must have constituted the equivalent of our libraries. See Fig. 59.

Stone and baked clay tablets were heavy and unwieldy. The practical genius of the Egyptians, under the pressure of their far-flung business enterprises, led to the discovery of a lighter and flat writing material, made from the fibers of the papyrus reeds that grew plentifully along the banks of the Nile. This was the forerunner of the paper of our own days, and with it the art of writing with a colored liquid on a flat surface was introduced, many centuries before the beginning of our era.

Other peoples readily recognized the advantages of the new way of recording but they lacked the raw materials for making paper. In time they found a very superior substitute for it in the skins of their animals. From goat and sheep skins they made parchment, and from the hides of their slaughtered calves they obtained vellum.

The physical appearance of the records went through a similar slow evolution from inconvenience to greater ease in handling. At first, long strips were made of the papyrus or parchment, and the writing was done across the narrow way, reminiscent of the clay tablets which they replaced. Next these scrolls were written on the long way, and soon the writing was broken up in blocks or "pages" that allowed for a more comfortable position of the reader's hands. Later the scrolls were folded in zig-zag or accordion fashion between the margins of these pages. Finally one side of these folders was punched with holes and laced and we have essentially the shape of our present-day book, except that it lacked a cover. Soon wooden boards were laced on for protection; when these boards were lined with leather and tooled with gold and ornamentation, bookbinding was born, and the bookbinder became an artist.

The craft flourished all through the middle ages along with the arts of

calligraphy and illumination. All three combined to produce magnificent works of a unique and intensely personal artistry. Examples of the highest achievements of the bookmaking crafts by handwork alone can be seen in private collections and museums.

With the invention of printing from movable type in the fifteenth century and the advent of a full-fledged paper industry that followed in its wake, books could be produced at a much lower cost. The bindings also gradually became simpler and more functional. Along with the art of printing, the old craft gradually evolved into a machine process, and became one of the so-called "allied" industries. Today the book trade puts out millions of well-made books in the familiar cloth bindings at extremely reasonable prices, when compared with the one-time high cost of handmade books.

For a long time machine-made books were rather tasteless articles reflecting in their make-up the chief preoccupation of low cost production. In recent years, publishers have made extremely commendable and successful efforts to design even their lowest priced books with taste and dignity in the choice of materials and decorations, as well as in the standards of workmanship in construction.

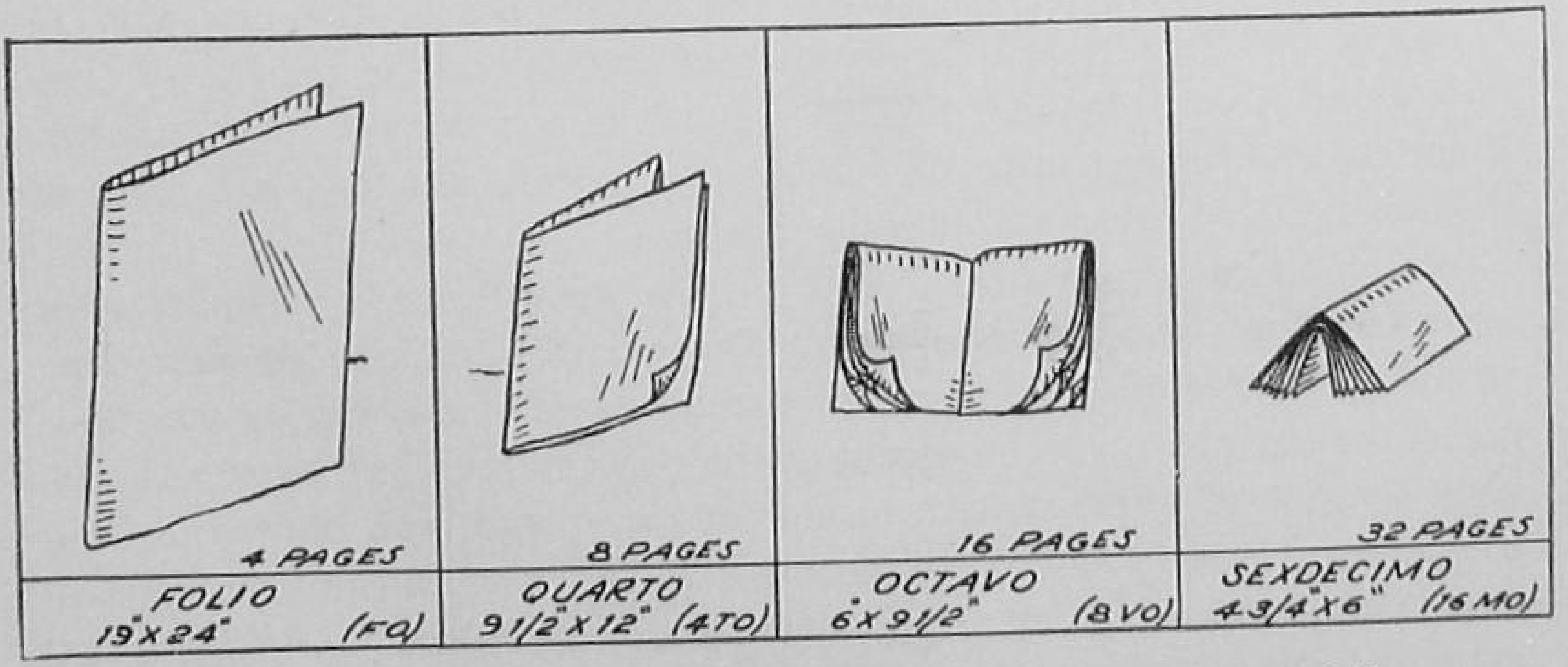


FIG. 60. Traditional sizes of books, derived from the number of folds.

TRADITIONAL SIZES OF BOOKS

In the past the size of a book was designated by an abbreviation of words of Latin origin derived from the number of leaves into which a standard sheet of paper 19" by 24" in area was folded to make a section.

When folded once, the press sheet made 2 leaves of four pages of 12" by 19". A book made up of sections of this size was called a folio volume. Folded at right angles again, into 4 leaves or 8 pages of 9½" by 12", the section became one for a quarto (4to) book. Folded three times the section gave 8 leaves with 16 pages 6" by 9½", and the book was called an octavo (8vo). The fourth fold resulted into 32 pages of 4¾" by 6" in sexdecimo (16mo) size. See Fig. 60.

The present-day trend is away from these traditional size designations. Publishers, in their catalogs and advertisements, prefer giving the exact page measurements in inches. But the hobbyist who is going to explore more fully the story of his craft will find that the old method of indicating the size of books is universally used in the older literature on the subject of bookbinding, and he should therefore be familiar with its meaning.

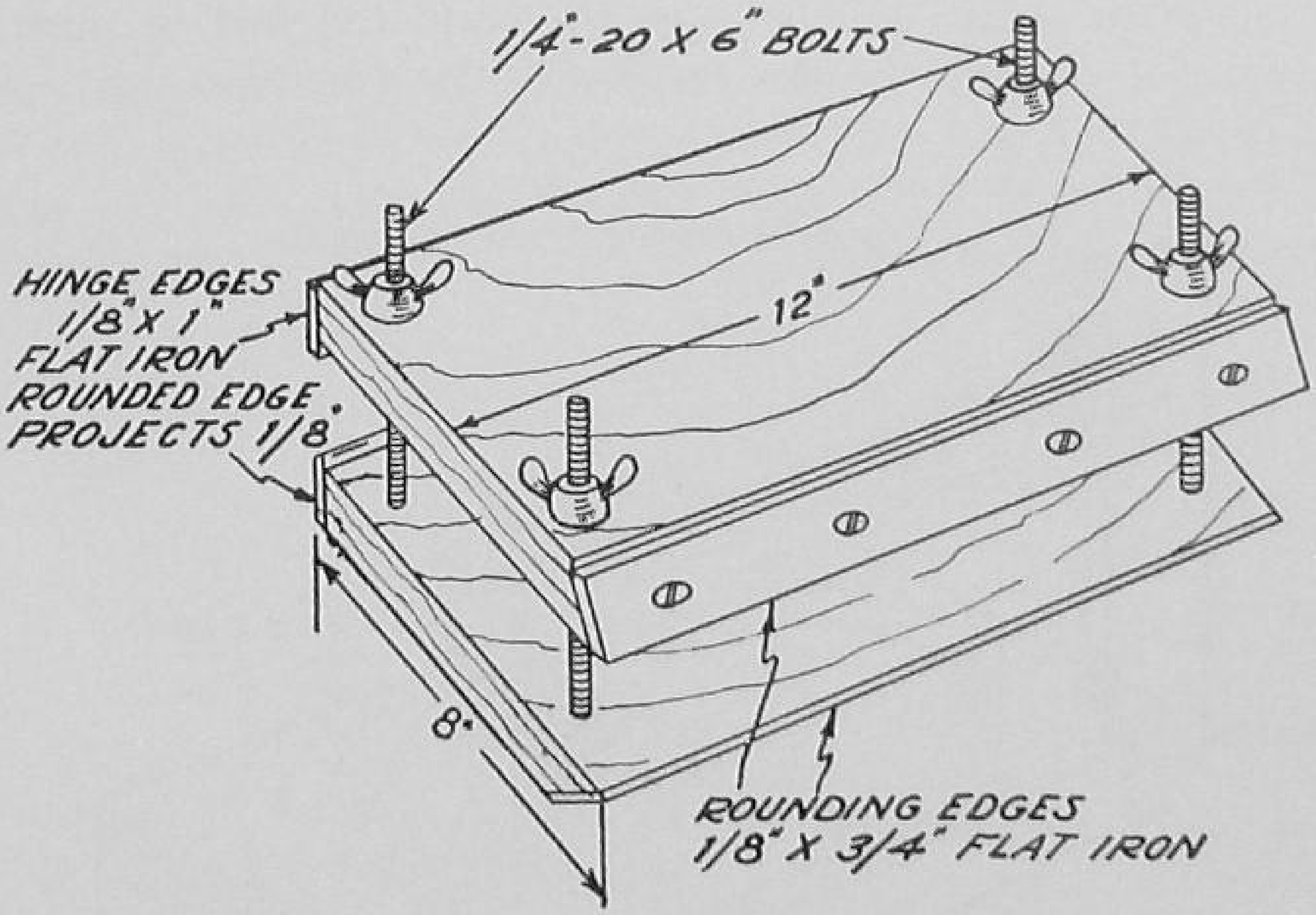


FIG. 61. The clamping press.

Our First Project

Although the richly tooled gold and even jeweled bindings of private and de luxe editions make attractive show pieces and represent the craft of bookbinding at its best, the beginner will likely be more interested in a neat, sturdily built book that serves and wears well after it is completed.

As a first experiment it is perhaps wiser not to work with irreplaceable printed material. When the new craftsman has become familiar with the

various steps of constructing a book he may substitute printed and consecutively numbered pages for the blank sheets used in the first book. Some publishers sell the printed sheets of their publications unbound when this service is specifically requested.

Only a few pieces of equipment are required to bind a book, and nearly all of them can be readily made in the home workshop at very little expense. Details for the construction of the most important ones, the clamping press and the sewing frame, are shown in Figs. 61 and 62. Some cardboard, paper and binder's cloth complete the working outfit. The directions here given are for a 4½" by 6" octavo folded book with blank pages, that may be used as an address book, a diary, an autograph or appointment book, or any other suitable purpose. This project will carry the beginner through all the stages of book construction, from the preparation of the signatures to the final decorating. In this practical "learn by doing" manner he will be introduced to all the principles of the craft and find in them ample inspiration and stimulus for the exercise of constructive thinking on his own part.

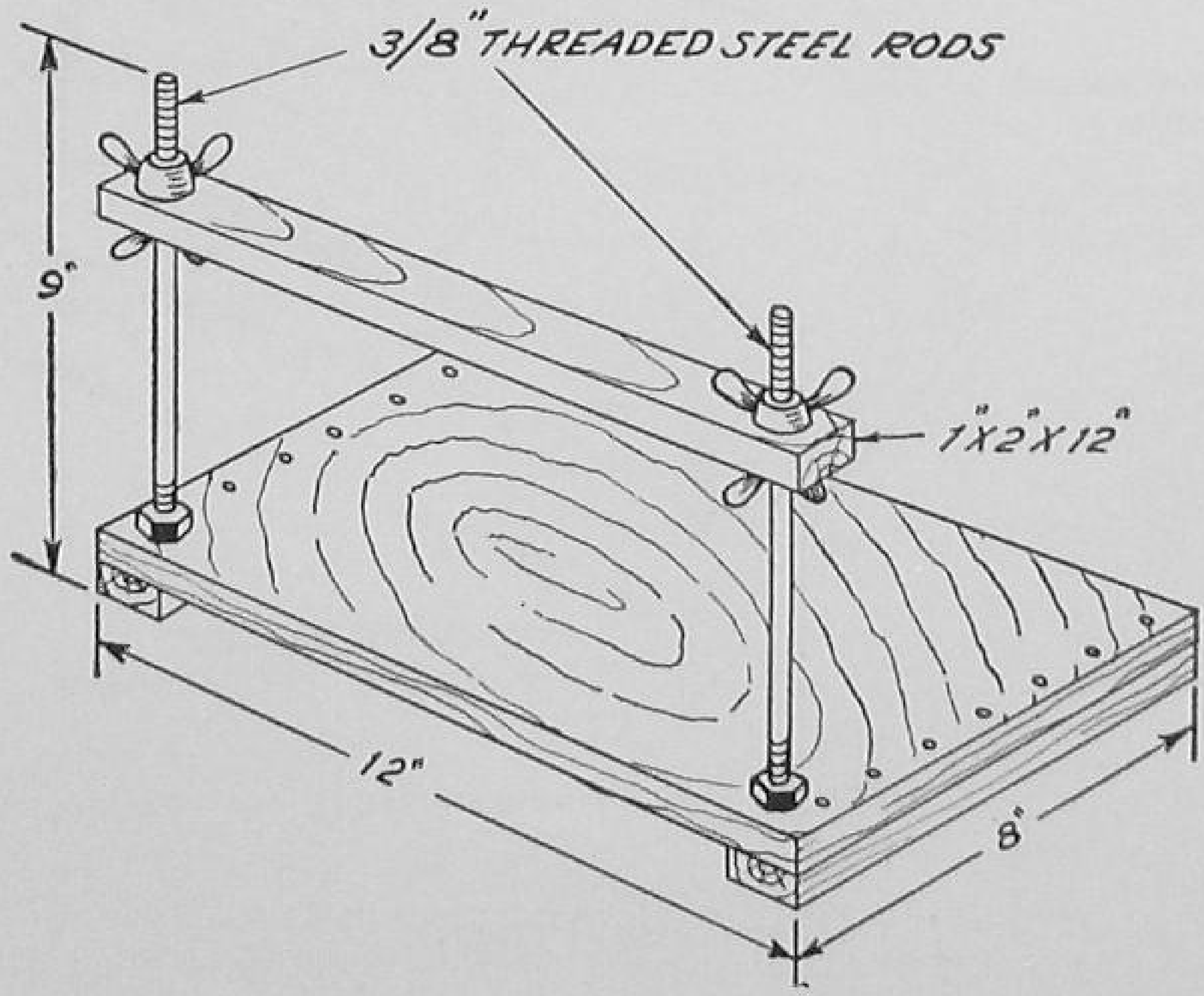


Fig. 62. The sewing frame.

Preparing the Signatures of the Book

The body of any book is made up from folded sheets of paper. When the press sheets for a printed book are folded, the pages must follow one

another in their numerical sequence. The pressman has foreseen this necessity, and he has placed or "imposed" the pages in a chosen order. The bookbinder must follow this pre-established order or plan in his folding operations.

When folded, each sheet has become a little pamphlet by itself. In our case, each blank sheet, folded three times at right angles, makes a pamphlet of 8 leaves or 16 pages. This pamphlet is called a signature. The average book-length novel of today is made up of 20 signatures of 16 pages each, or 10 of 32 pages, according to the size of the press on which it was printed. If you examine the books on your shelves you will find that the number of pages in them will nearly always be a multiple of sixteen, all blank pages counted in.

Making the Signatures.

You may make as many unprinted signatures for your blank book as you wish. The bulk of the paper will have an influence on the choice of the number of sections, as it determines the thickness of the book. For our specific project we shall plan to make 10 signatures, using paper of average weight.

From a paper dealer or a neighborhood printer obtain 5 mill sheets, 25″ x 38″, of book paper. Cut these sheets in 4 pieces, each 12½″ x 19″. Place the resulting 20 sheets in a stack with the 19″ edge running parallel with the edge of your table. Bring the far long edge of the top sheet

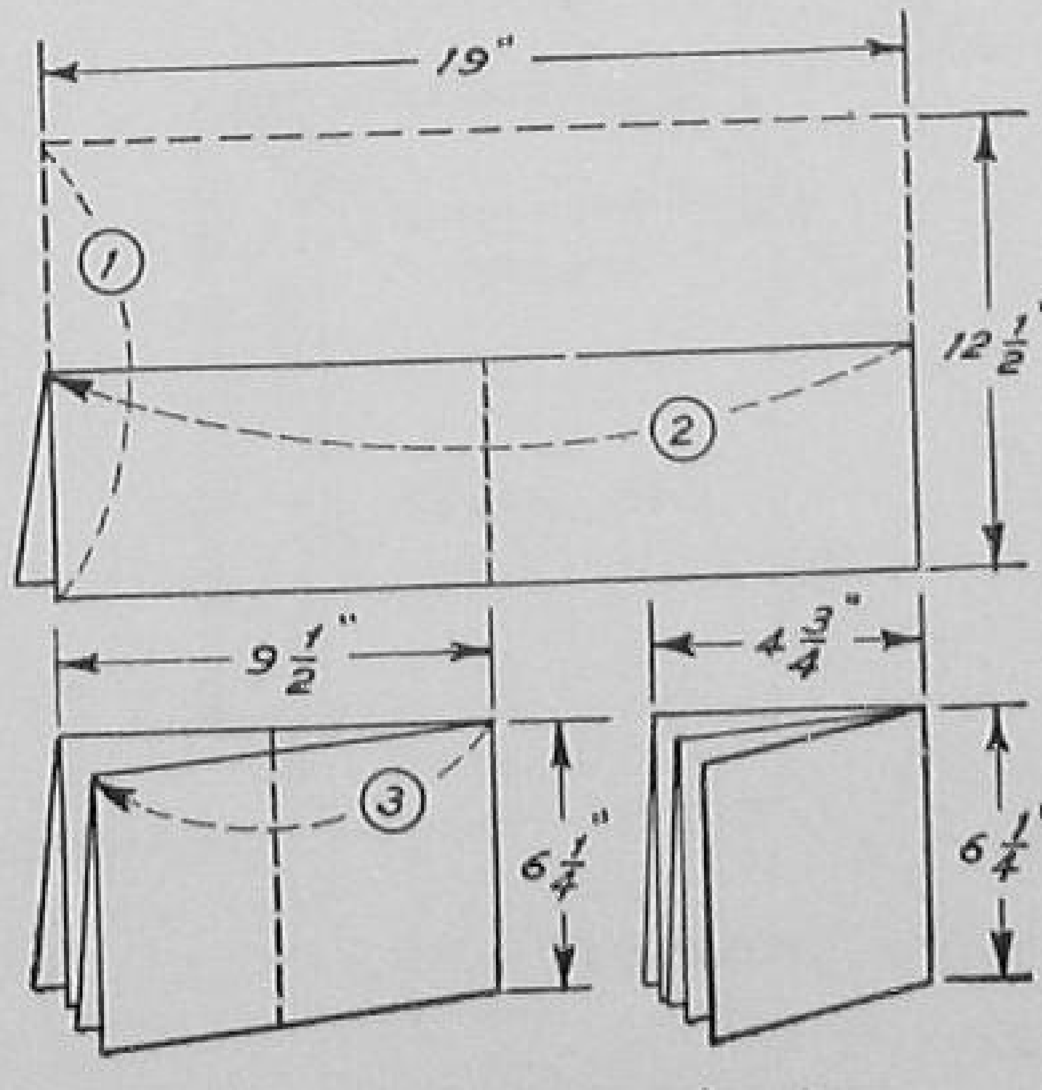


FIG. 63. Folding a signature.

towards you so that the two ends of the sheet meet exactly. Crease the fold with a bone folder or a toothbrush handle. See Fig. 63.

Now fold the doubled sheet from the right to the left, lining up the right edge parallel with the left one and a scant $1/16''$ of an inch short of covering it. Crease the opposite end. Now fold again from right to left, but this time line the two overlapping edges exactly. Crease again. This completes your first signature.

Fold all the remaining sheets in the same manner. If all the work has been done with care and accuracy, you will now have 20 signatures. Select the ten best and put the others in reserve to replace any spoilage later on.

Pile the 10 signatures neatly together and compress them as hard as you can to drive all the air out of the folds. A mallet may be used to tap along the folded edges. The flatter the signatures are, the easier they will be to handle in the work to follow.

Marking and Sawing.

The longer one of the folded edges will become the back of your book; the shorter fold will make the head. The two opposing open sides will be, respectively, the front, or fore-edge, and the foot, or tail, of the book. The terms "back," "head," "fore-edge" and "tail" are the technical nomenclature for the parts of the book, and the student should train himself to use them rather than substitutes of a lesser technical precision. See Fig. 64.

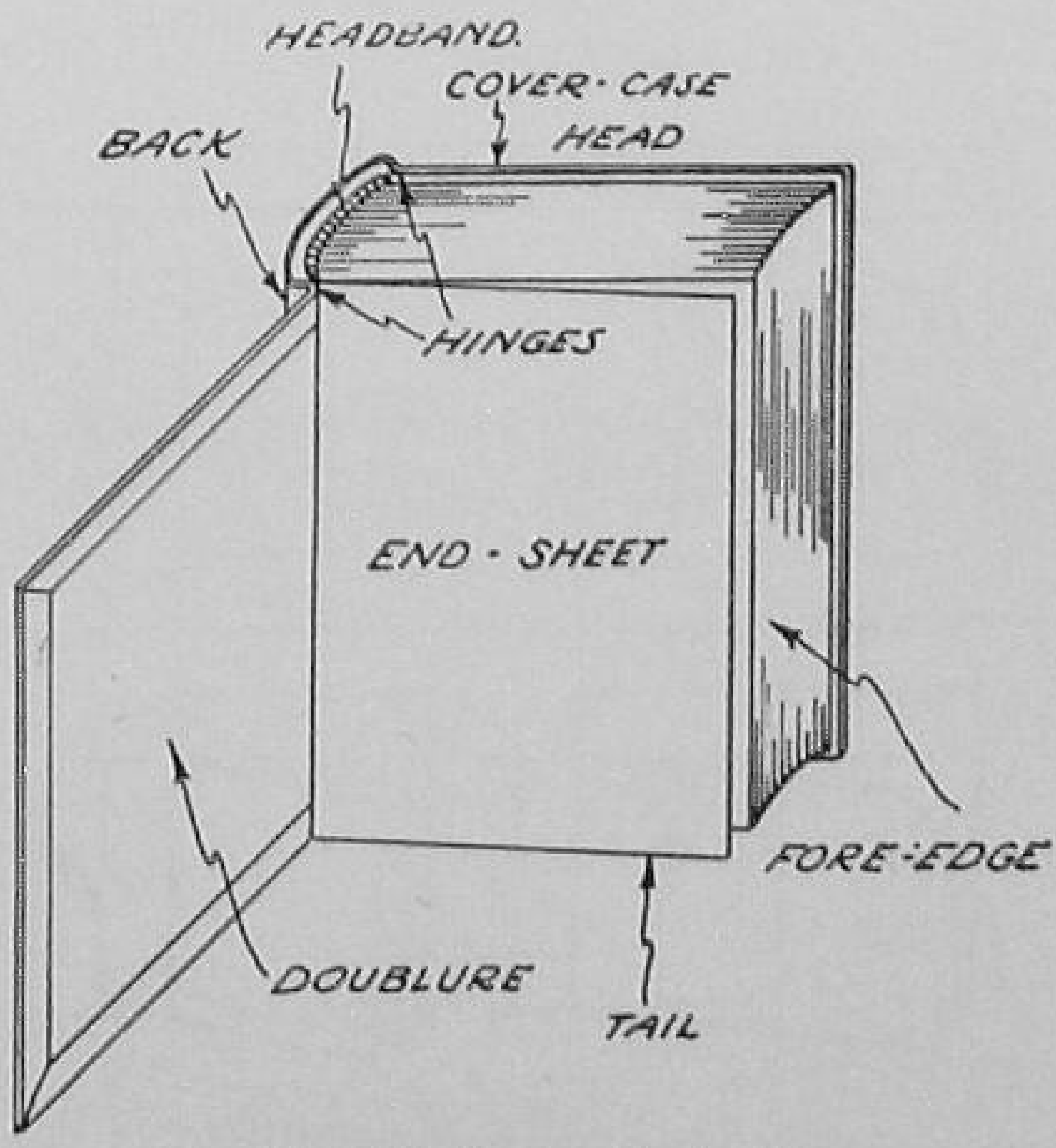


Fig. 64. Parts of a book.

Stack the 10 signatures all the same way in a neat pile, jogging them to the back and the head. In a printed and page-numbered book, care must be taken to collate the signatures in their proper sequence. Keeping the pile in perfect alignment, clamp it into the clamping press, with the back extending beyond the beveled edges of the boards for about ¼". With a ruler and a pencil make the following marks, starting from the corner of back and head: ½", 1⅝", 2", 4", 4⅜", and 5½". See Fig. 65. With a

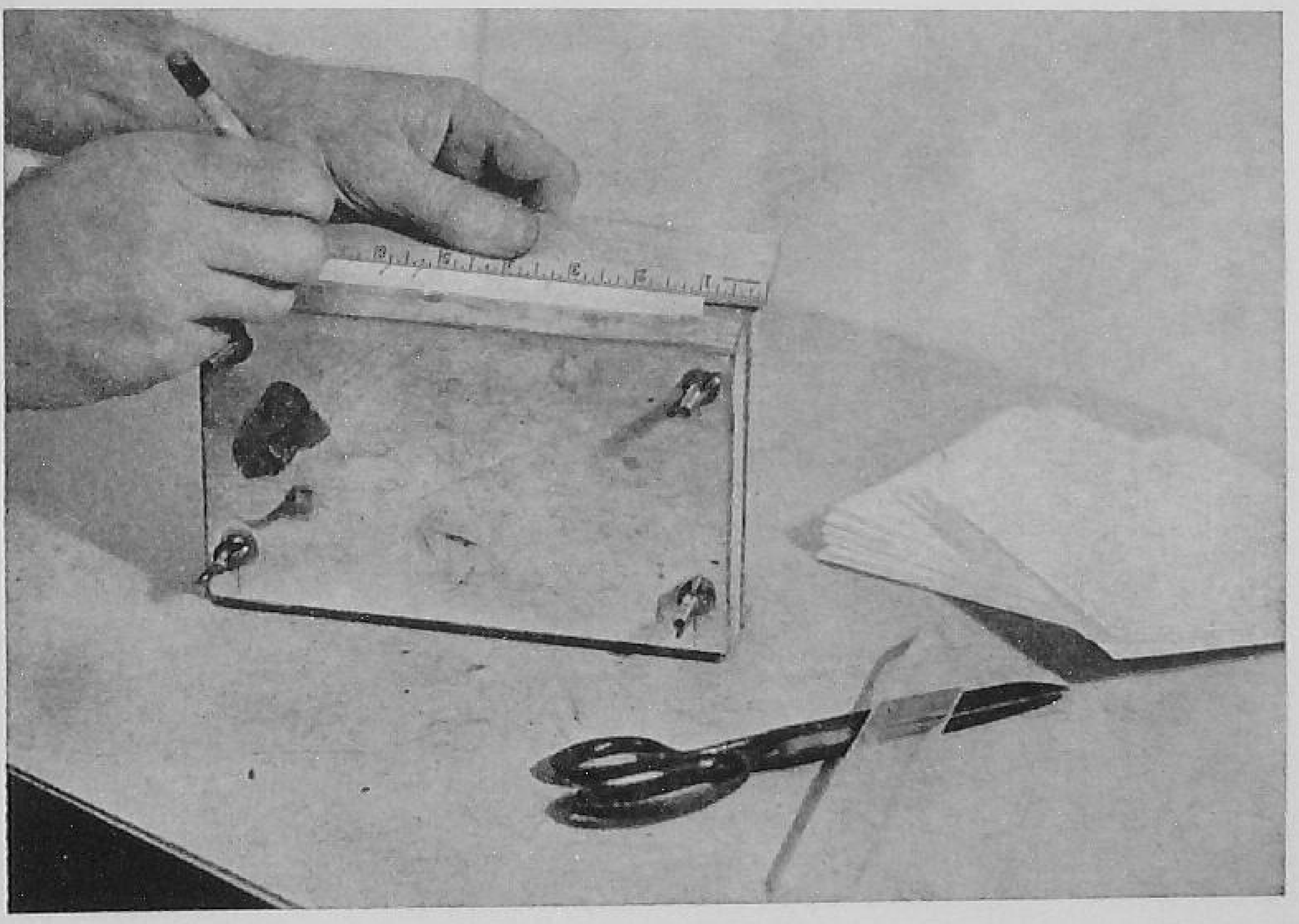


FIG. 65. Marking the back with pencil.

try square draw a straight line across the back at each of these markings. Now take a fine backsaw or a hacksaw and saw the paper along the marked lines to a depth of not more than 1/16". The purpose of the sawing is to open all four layers of paper for the passage of the needle and thread in sewing. See Fig. 66. The spacing given for the cuts provides for two tapes, which are enough for a small book. When making larger books allow for more tapes, remembering that you need to make a single cut ½" or so in from each end of the signatures and a cut on either side of each tape. Space the tapes equally in the distance between the two outer end cuts. Your signatures are now ready for sewing. See Fig. 67.

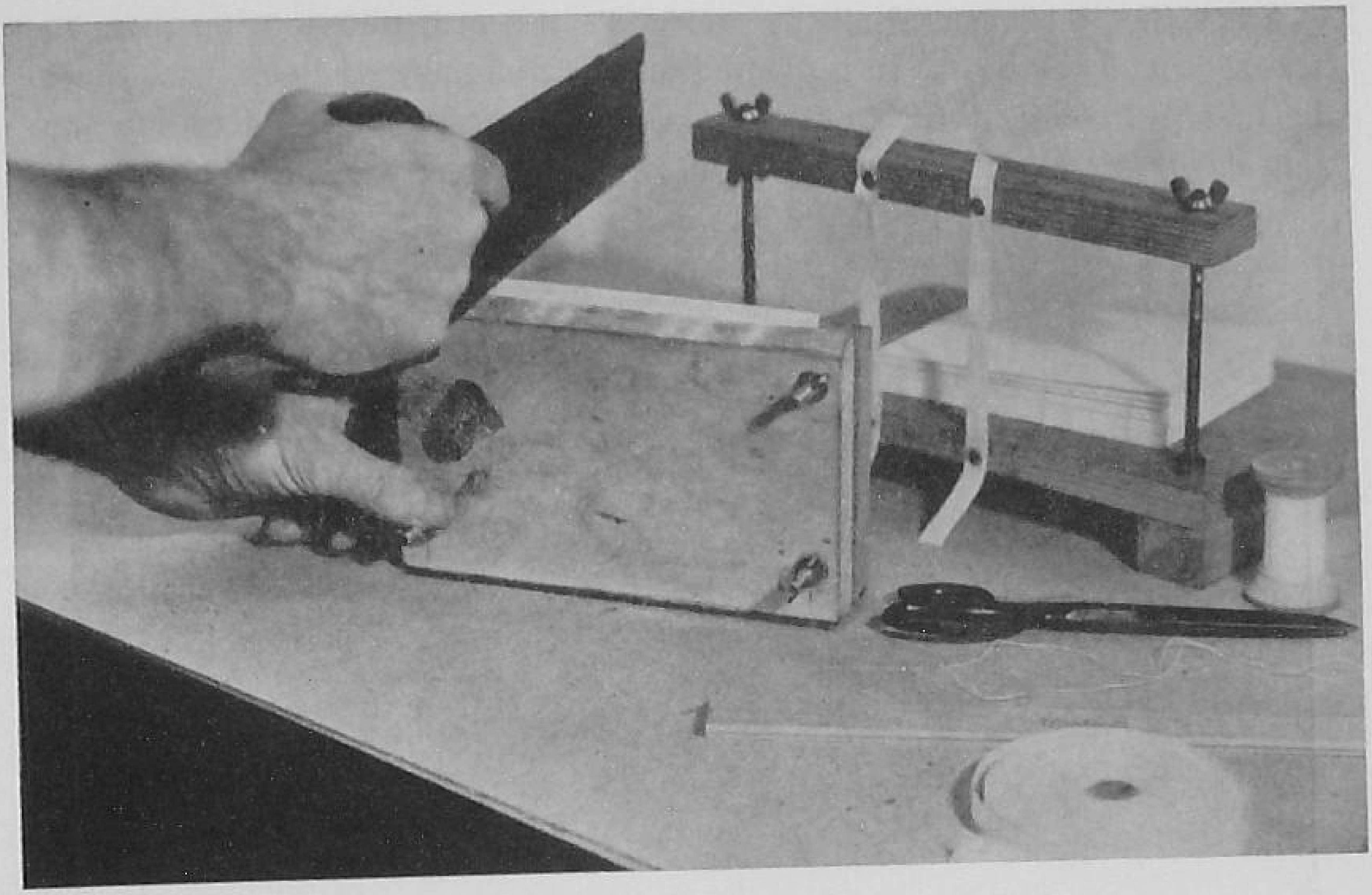


FIG. 66. Sawing the paper.

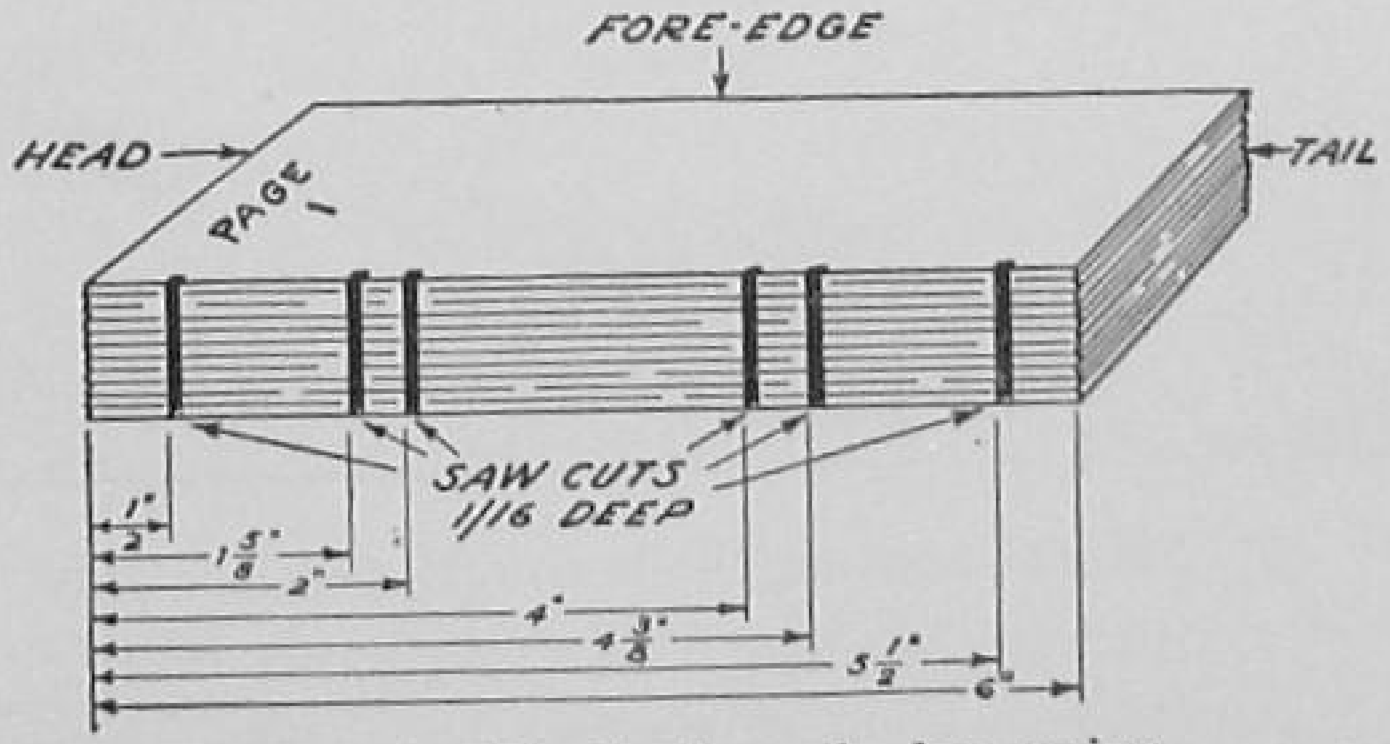


FIG. 67. The book ready for sewing.

SEWING THE BOOK

For sewing, you will need the frame illustrated in Fig. 68, two pieces of ⅜″ white cotton tape from any dry-goods store, a blunted darning needle, and a spool of strong linen thread.

Preparing the Frame.

With thumbtacks fasten one of the strips of tape near the center of the edges of the table and crossbars of your sewing frame. Make sure the

tape runs straight up and down at right angles to the table. From the edge of this first tape, measure exactly 2″ and similarly fasten the second tape to run parallel with the first one.

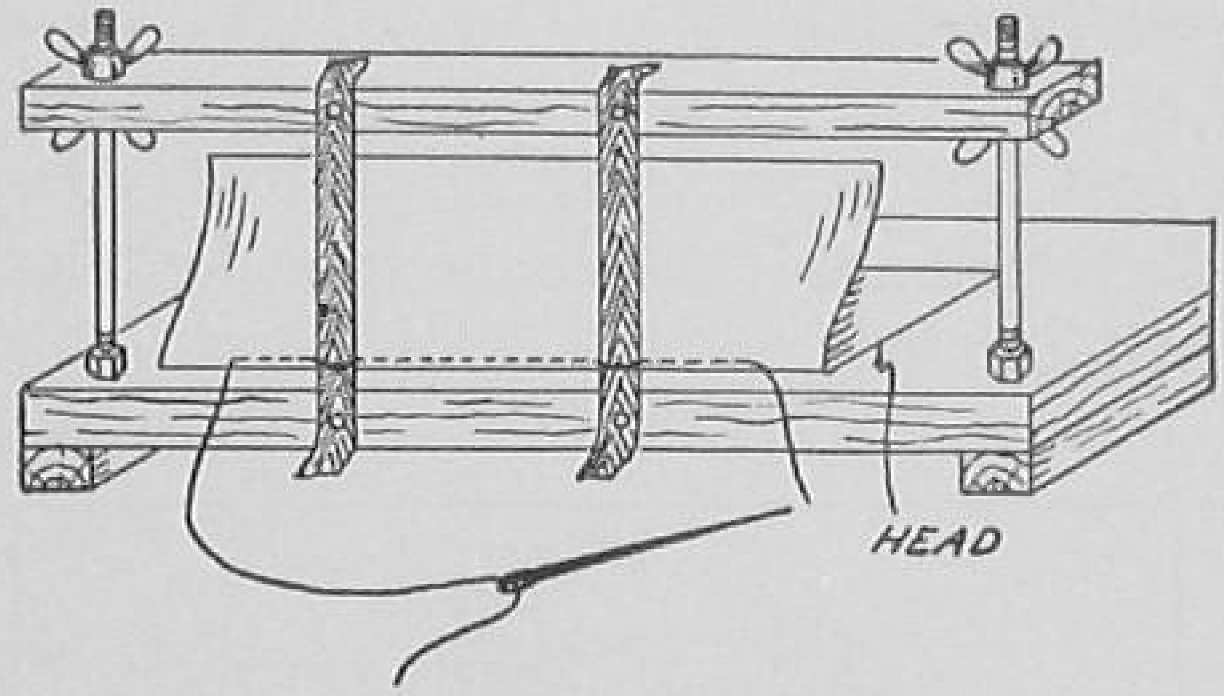


FIG. 68. Sewing the first signature.

Loosen the wing nuts above the crossbar, backing them up a few turns. Tighten the ones below the crossbar until the tapes are reasonably taut. Firmly stretched tapes make for much easier and more accurate sewing.

Sewing the First Signatures.

Now from your pile of notched signatures take the first one, and turn it over; lay it on the frame so that the back will be to the tapes and the head to your right.

Thread your needle with #25 thread. Do not make a knot at the end of the thread. With the left hand, open the signature in the center fold, and with the right hand insert the needle through the first saw slot from the right. Draw the thread through and leave only about 3″ of a tail hanging loose. Pass the needle out again at the next notch, on the right side of the first tape, then around this tape and in again at its left through the third saw notch. Go around the second tape in similar fashion and bring the thread out again through the single left-end notch.

Now take your second signature from the pile, turn it over so as to make page 17 fall on the end sheet of the sewed section, and attach it to the tapes, working from left to right this time. When the thread comes out at the extreme right-end notch, press the two sections firmly down on the table of the frame, pull the thread reasonably tight and knot the running thread and the tail end left in the beginning.

The Kettle Stitch.

The third signature follows in the right-to-left direction again, in the same way as the first. Before entering the fourth, pass the needle between the first and second section and then through the loop of the thread to firmly tie the 3 signatures together. This is called the kettle stitch. See Fig. 69. Use it at each end from now on to secure each new signature to the proceding ones both at the head and the tail. After sewing the last signature, loop the thread about the needle to make a knot and cut it off, leaving abcut a half-inch long tail.

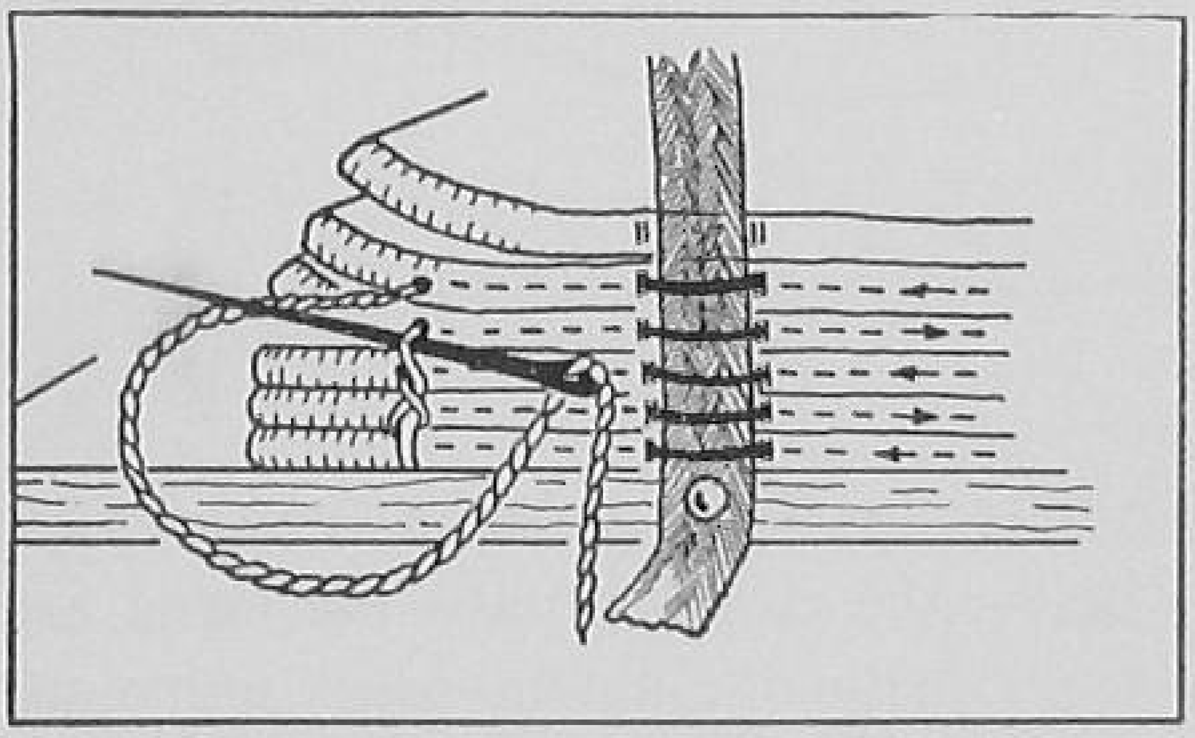


FIG. 69. The kettle stitch.

Thread Splicing.

One threading of the needle will not be enough probably for a book of many signatures. In joining the new thread to the old one, make sure the knot will come to lie on the inside of the book. Measure your thread so it will preferably come between the two tapes. Make a flat knot that will be able to pass through the sawed holes without tearing the paper. See Fig. 70.

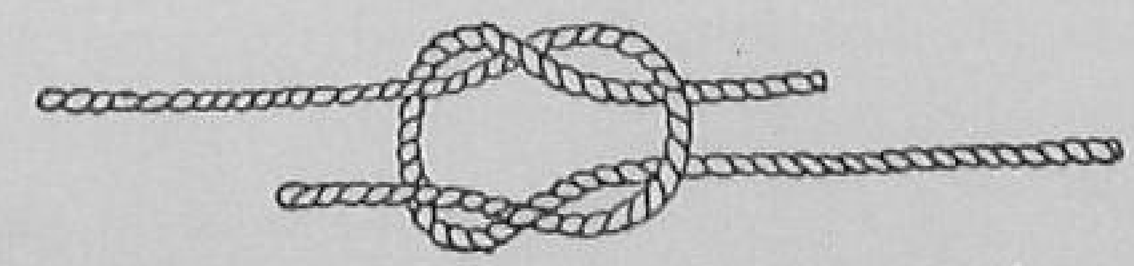


FIG. 70. Knotting new and old thread.

GETTING THE BOOK READY FOR THE CASE

In the bindery trade the various operations performed to prepare the sewed book for attaching it to the separately made covers are summarized under the expression of "forwarding the book." In the next few pages the

forwarding process has been broken down into a number of steps that will carry the book through to the finishing stage.

Gluing the Back.

We shall first reinforce the sewing with glue spread all along the back and slightly worked between the signatures with a stiff brush. Any good glue may be used, or a paste may be made at home by mixing ½ cup of ordinary flour and a teaspoonful of powdered alum with enough water to make a thin mixture. Add 2 cups of boiling water and let simmer for a few minutes, meanwhile stirring. Adding a few drops of glycerine will keep the paste flexible when it has dried on the book.

End-Sheets.

While the back is partially drying, cut two sheets of a decorative paper for your end sheets. They must be exactly double the page size of your book so as to make a folio, or 4-page, folder of that size. Decorated wrapping papers, wallpapers or plain colored ones that harmonize with your binding materials are all suitable for end sheets. If you are familiar with the art of marbleizing with water and oil colors, you can make your own artistic end papers.

When the back of your book is almost dry, you can attach the end sheet folders to the first and last pages of your book with just a narrow ¼″ strip of paste along the back fold. See Fig. 71.

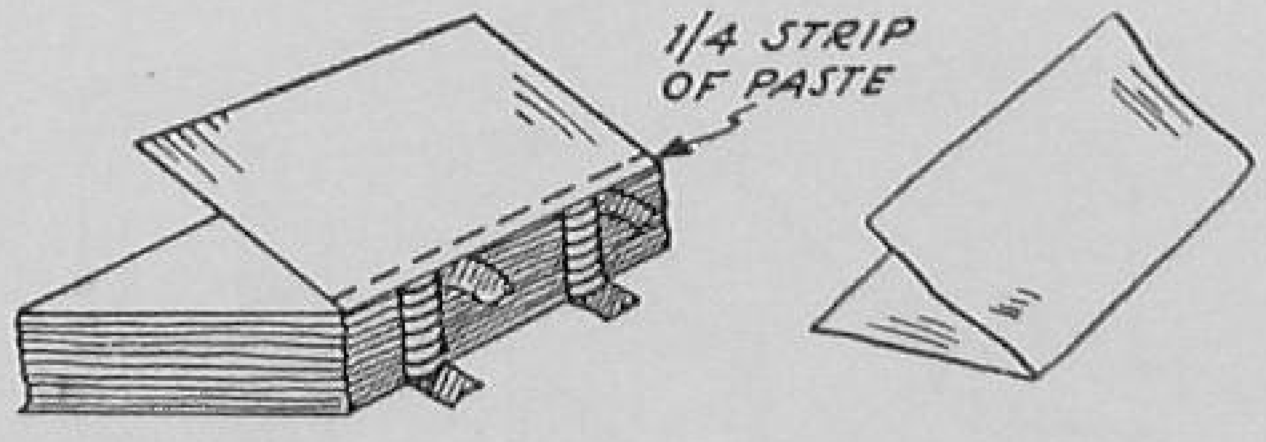


FIG. 71. Attaching the end sheets.

Trimming the Book.

While the glue of the back is still tacky, you can proceed to the trimming of the fore-edge, head and tail edges of your book. The best way is, of course, by using a printer's guillotine cutter. Few amateur binders, however, will have ready access to such a machine. However, a pair of boards slightly larger than the size of your book, a very well-sharpened, flat, carpenter's chisel of about 1″ width and a vise, or, in its absence even a pair of C clamps, will make a satisfactory trimming outfit.

First lay out a pencilled guide line along the fore-edge about ⅛" in from the edges of the paper and positively parallel with the back. At right angles to this line and the back also draw a line ⅛" below the head and above the tail of the book.

As the book is slightly thicker at the back than through the body because of the sewing, lay two pieces of thin cardboard of the same length as the pages and about ½" narrower against both the first and last sheets, somewhat like a temporary cover. Line the front piece up very accurately with the pencilled guide line, along the fore-edge, but let the back piece project up to the level of the untrimmed fore-edge.

Lay this whole assembly between two fairly heavy wooden boards, with the front one accurately lined up with the cardboard under it, along the scribed line of the fore-edge. The back board should protrude beyond the edge of the book to make a stop against which to bear with the cutting edge of the chisel. Clamp the book and boards in a vise or between two two C clamps, taking great care not to disarrange the line-up.

With the blade of the chisel moving flat on the edge of the front board take a series of paring cuts from left to right and back again all along the fore-edge, until all the pages are trimmed quite smoothly and evenly. See Fig. 72. Next cut the head in the same way and then the tail end of the book. Make quite sure that all three sides are exactly at right angles to each other.

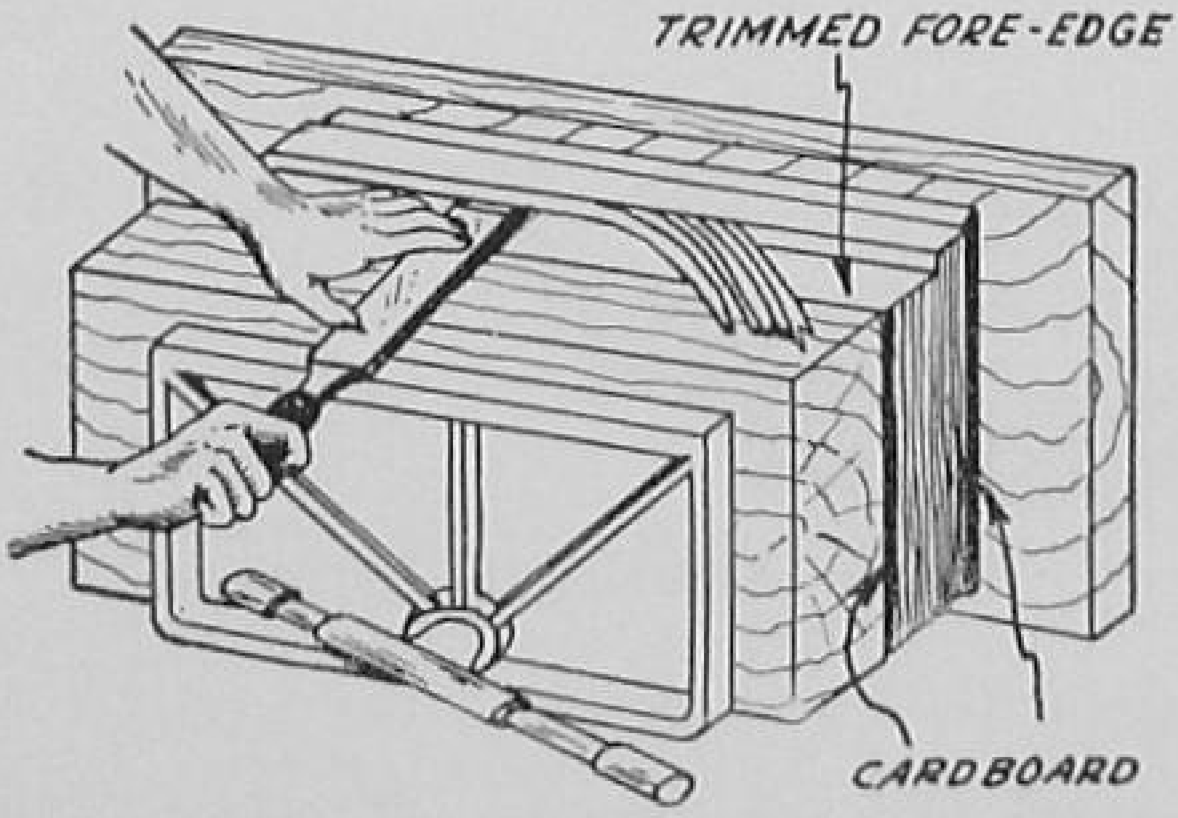


FIG. 72. Trimming with a flat wood chisel.

Rounding the Back.

Now lay your book flat on the table with the fore-edge toward you. Stem the thumb of the left hand against the fore-edge, and with the other four fingers pull the body of the book against the thumb. At the same

time tap the upper line of the back with light glancing blows with a hammer or mallet. Continue this treatment, alternately turning the book over, until the fore-edge has been shaped evenly concave and the back correspondingly convex. See Fig. 73.

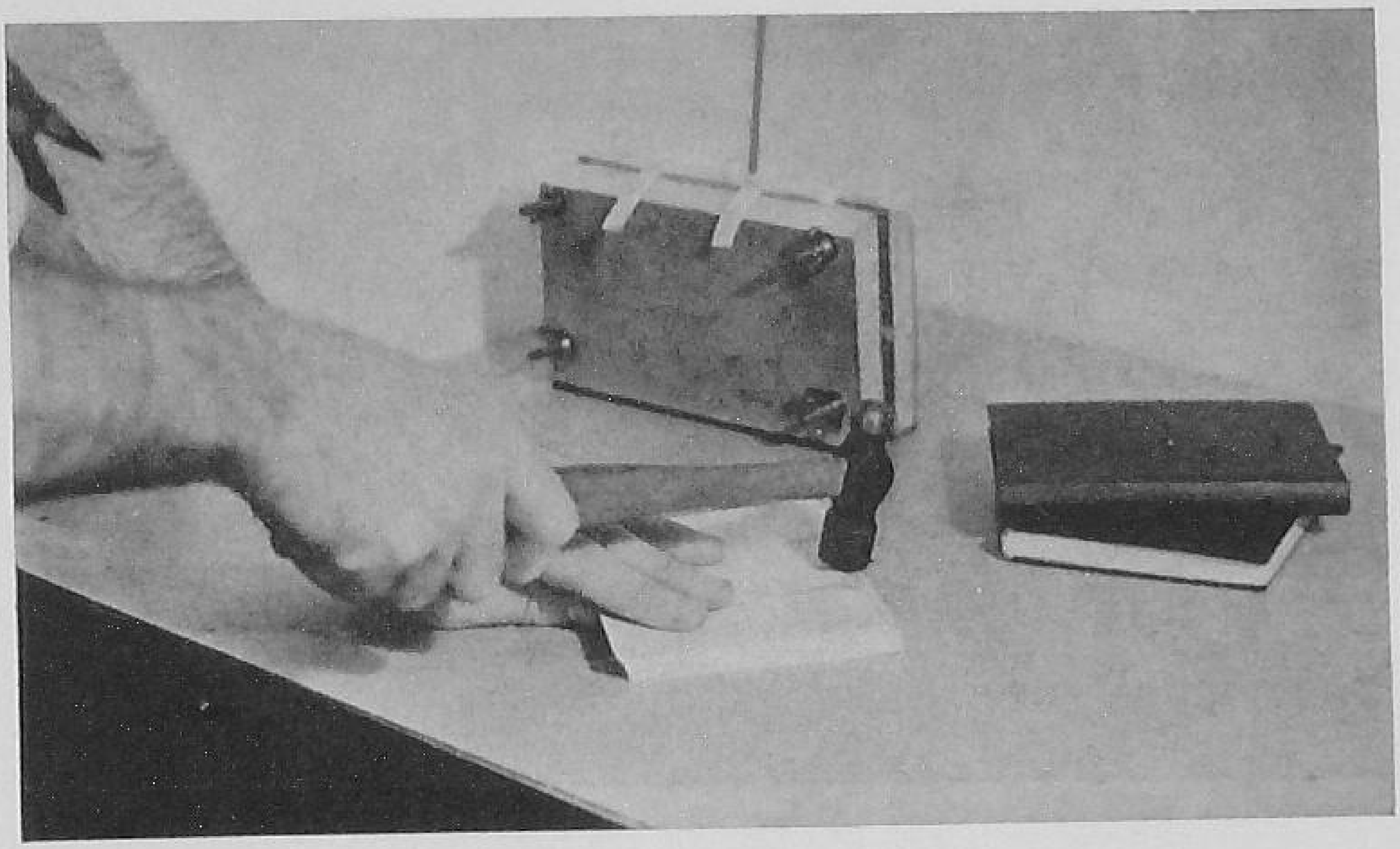


FIG. 73.

Shaping the Back.

The cover boards will later add to the thickness of your book. The combined bulk would be greater than that of the rounded back as it is now. To avoid an unsightly step-down in thickness, and also to allow the book to open and lie flat we shall have to round the back still further, flaring it out to both sides for as much as the thickness of the casing boards.

Clamp the book in the clamping press from the beveled backing side. Allow the edge of the back of the first and last signatures to protrude about 1/8" above the bevel line of the press-boards. Align them evenly and then tighten the wing nuts well. Now hammer lightly along the left and right sides of the back, and repeat until the flaring is full and even on both sides. Start hammering in the center and strike light glancing blows only; actual pounding might damage the signatures and weaken the paper or even wear it through. See Fig. 74. If the glue is still tacky the back will hold its new shape easier upon drying, but the hammer may pull some

of the fibers of the paper with it. Rub the entire back with talcum or French chalk, and put a little of the same dusting powder on the face of the hammer or mallet.

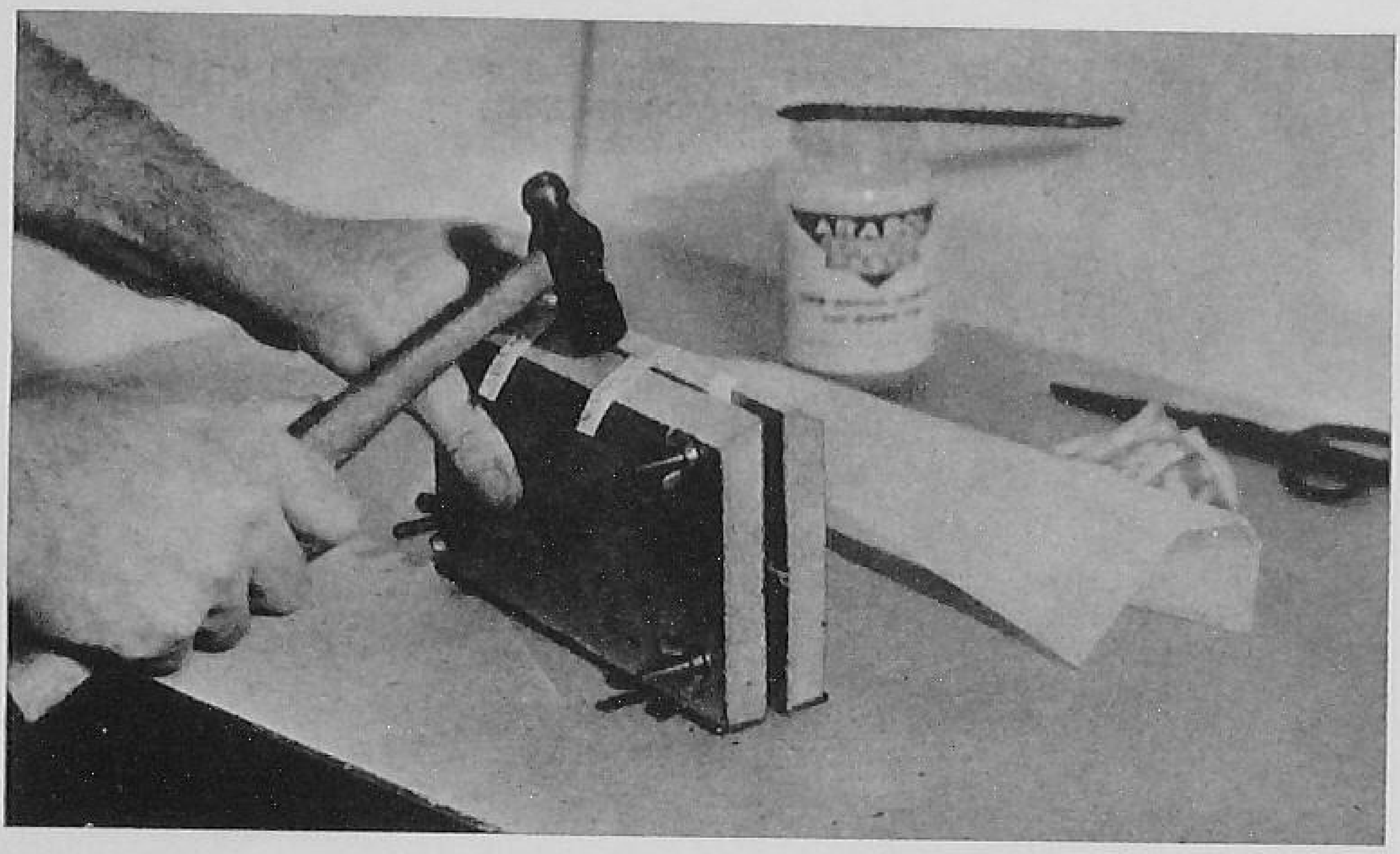


FIG. 74. Shaping the back.

The Headbands.

Headbands can be bought in assorted colors and materials. The cost is only a few cents for a yard length. If you prefer making your own, all you need for a book is a few inches of string about 1/16″ in diameter and a piece of appropriately striped cloth. The color should, of course, harmonize with that of the binding material to be used for the case.

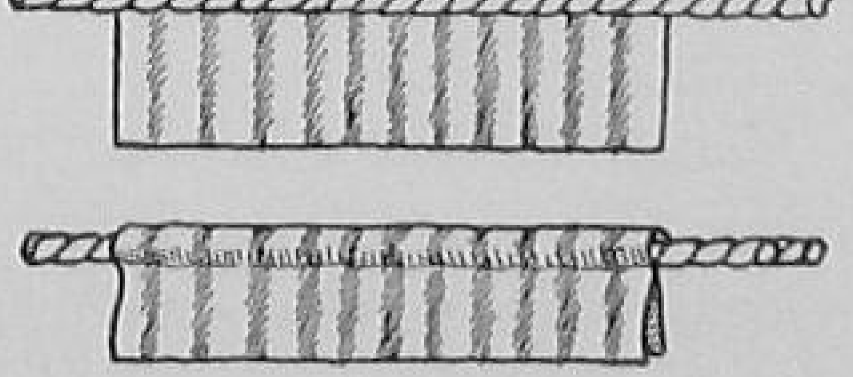


FIG. 75. How to make a headband.

Cut the cloth into a 2″ strip and a little shorter than the length of your string. The stripes should run the 2″ way, or at right angles to the string. See Fig. 75. Lay the string in the center, at right angles to the color stripes, rub flexible paste over the whole inside and fold the cloth over the string. Press firmly together and let dry.

Cut off two pieces of exactly the same length as that of the convex

rounding of the back of your book. Paste one at each end of the back, that is at the head and the tail, letting just the covered string piping project over the ends of the back. See Fig. 76.

The headbands serve both as a decoration and to reinforce the ends of the back.

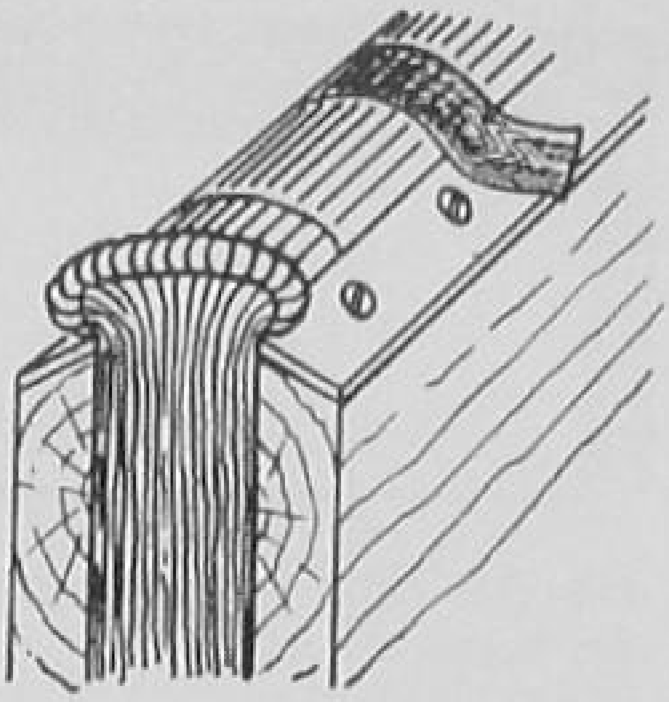


FIG. 76. Attaching the headband.

The Super-cloth.

While the headbands are drying on the book, cut a piece of super-cloth (obtainable from bindery supply houses) or a piece of starched and sized cheesecloth, crash, or crinoline to 3″ wider than the thickness of the rounded back and ½″ shorter than its length.

Center this cloth over the back, leaving equal margins at head and tail between the edge of the cloth and the burr of the headbands, and free flaps of equal width along both sides of the long way of the back. Take a little paste on your fingertips and rub it well into the cloth where it is in contact with the back. See Fig. 77. To make sure that the paste so applied will not, at some later date, become saturated with moisture, become sticky and adhere to the hollow back of the book, cover it up with a thin sheet of paper pressed into the tacky cloth.

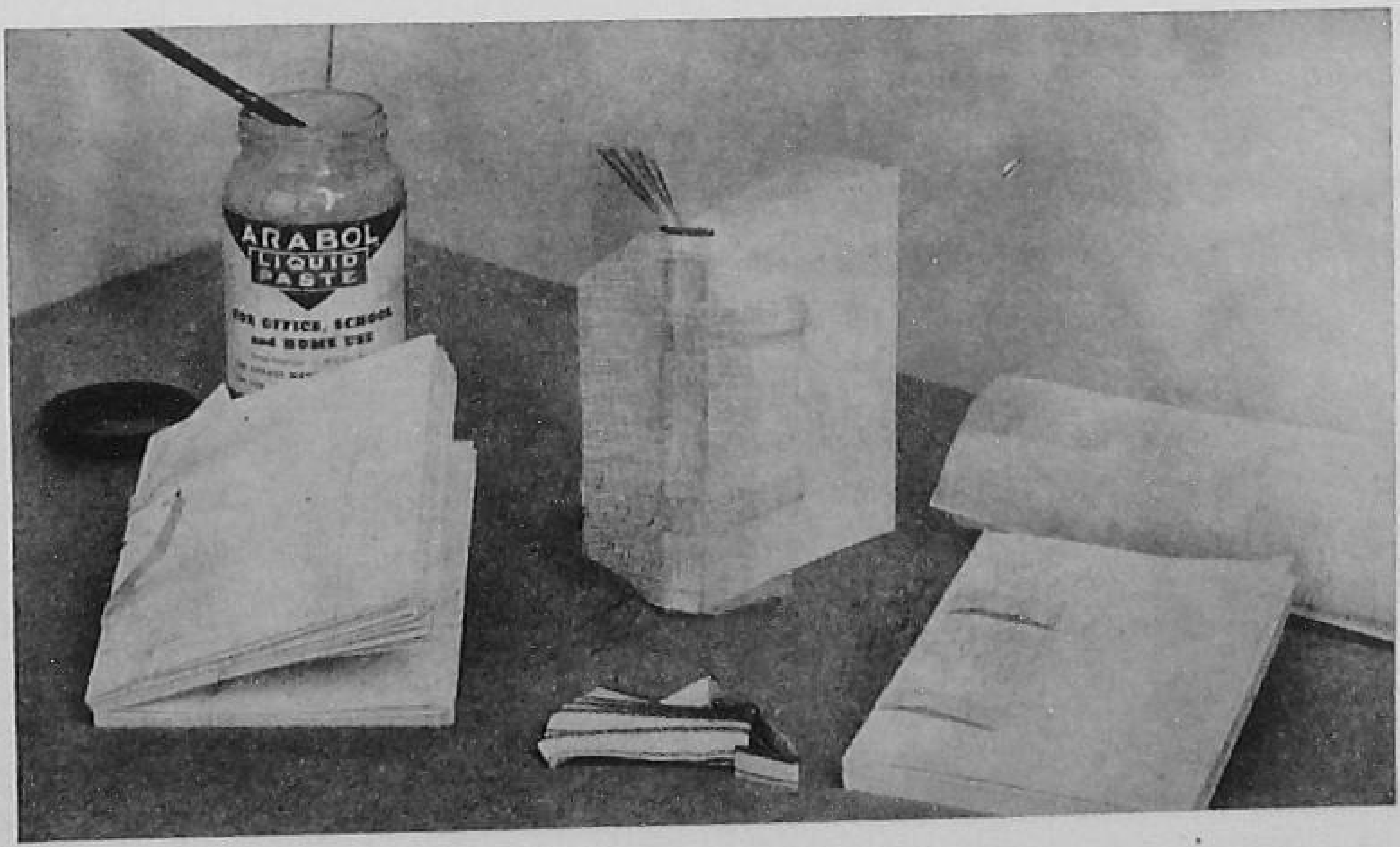


FIG. 77. Attaching the headbands and super-cloth.

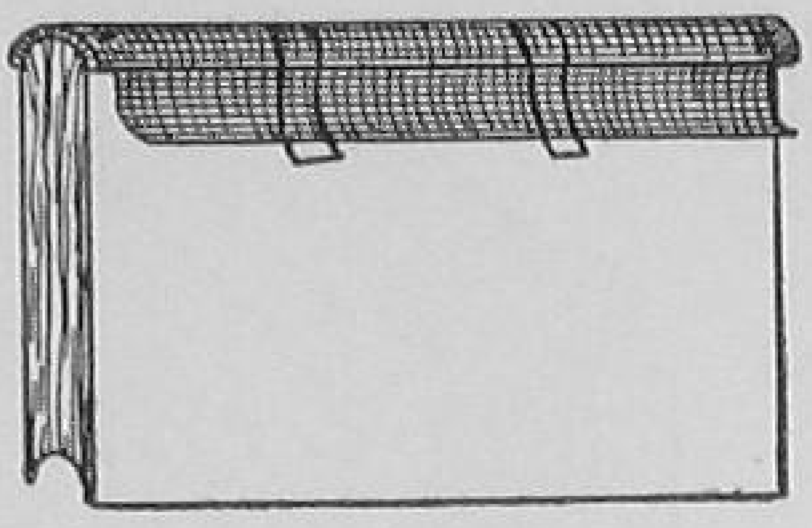


FIG. 78. The book ready for the case.

While the paste is still moist take a short piece of dowel pin, and, as if with a rolling pin, roll over the entire back to smooth it evenly wherever bumps appear. Your book is now ready for casing-in, and our next job is to construct the case or binding. See Fig. 78.

MAKING THE CASE

The case is made from cardboard and binder's cloth. A knife, a ruler, a pair of scissors and a bone folder are all the tools required for its construction.

The Boards.

Binder's board is a specially made type of stiffly sized cardboard that is available in a variety of thicknesses. In the process of its manufacture its fibers align themselves in the direction the sheet is traveling through the paper-making machine. Therefore the board has a definite grain which must, in the book, run the long way of the cover. Covers in which the grain runs across the width of the sheet will warp when moistened with the paste.

Commercial binderies cut their boards with guillotine-type paper-cutting machines, which insure perfectly square edges. Scissors or tin snips will round-bevel them; a better way to cut your boards is to use a metal straightedge and a sharp knife.

Cut two boards the same width as the outside pages of your book from the inside of the flare to the force-edge and 1/4″ longer than the paper page. Check both these dimensions on your book.

Measuring the Back.

When you place these two boards on the book you will find that they extend 1/8″ both at the head and the tail. Now arrange them so they project the same amount over the fore-edge. Between the opposite edge of the boards and the flared back there will now be a groove of 1/8″ in width. This is the space allowed for the hinges of your cover.

Keep both boards accurately in the position described, and lock the book in either the clamping press or a vise, with the back at least one-quarter the width of the covers exposed beyond the holding jaws. While the book is thus held rigidly and both your hands are free, cut a 4″ strip of gummed

paper tape and paste one end for about ½″ to either one of the cover boards. Stretch the tape over the back, forcing it into the hinge groove with a bone folder, then over the rounded part of the back into the other groove and down to the opposite board. The gummed tape is now accurately molded over the entire back. One of these spacing strips may be enough for a small book, but on larger ones two should be applied, one near each end of the back. See Fig. 79.

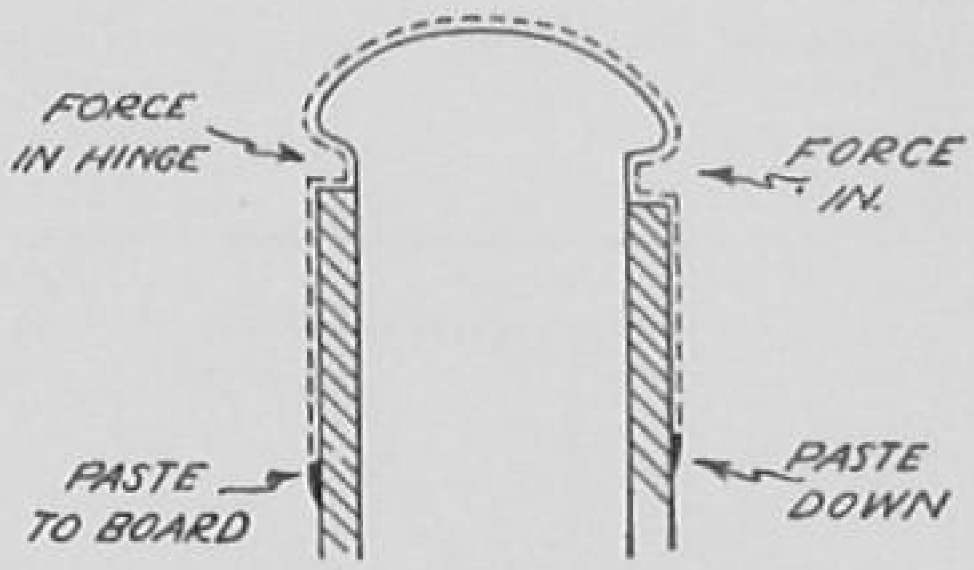


FIG. 79. Path of the back-measuring strip. Use gummed tape.

Now remove the book from the clamping device and open the boards flat, stretching the gummed paper tape tightly. The distance between the two boards represents the amount of cloth needed to make a tightly fitting but well-hinged back for your book.

Cutting the Binding Material.

Binding materials are many and varied. We shall consider leather, the classical binding medium, in a separate discussion further on in this chapter. For this first project in bookbinding we shall assume that the student is working with the less expensive and more utilitarian bookbinder's cloth used in commercial bindings of the day.

Binder's cloth is variously sold under the names of buckram, art linen, or art vellum. However, almost any fabric may be used for binding books, as exemplified by the man who bound his successive diaries in the remnants of the suits he wore during the periods covered in them. A material that is in some way suggestive of the contents of the book is of course more appropriate than the usual low-priced commercial article.

Paper is often used for binding. Sometimes a combination may be used of cloth for the back and paper for the boards, or again a combination of leather and cloth in which the back is covered with the leather extending only slightly beyond the hinges for a quarter binding or well on to the boards for a half binding.

From your chosen material cut a piece ¾″ larger in all four directions than the outside dimensions of your tape-spaced and flatly opened boards. Turn your cloth over on a clean table, so the "wrong" side faces up. With a ruler and pencil draw a straight line ¾″ from the top edge and parallel

to it. Line up the top edge of the taped boards along this line, leaving equal outside margins at right and left beyond the boards. See Fig. 80. Trace a close outline of both boards with a sharp pencil line, and lift the boards off the cloth. Remove the gummed tape strip.

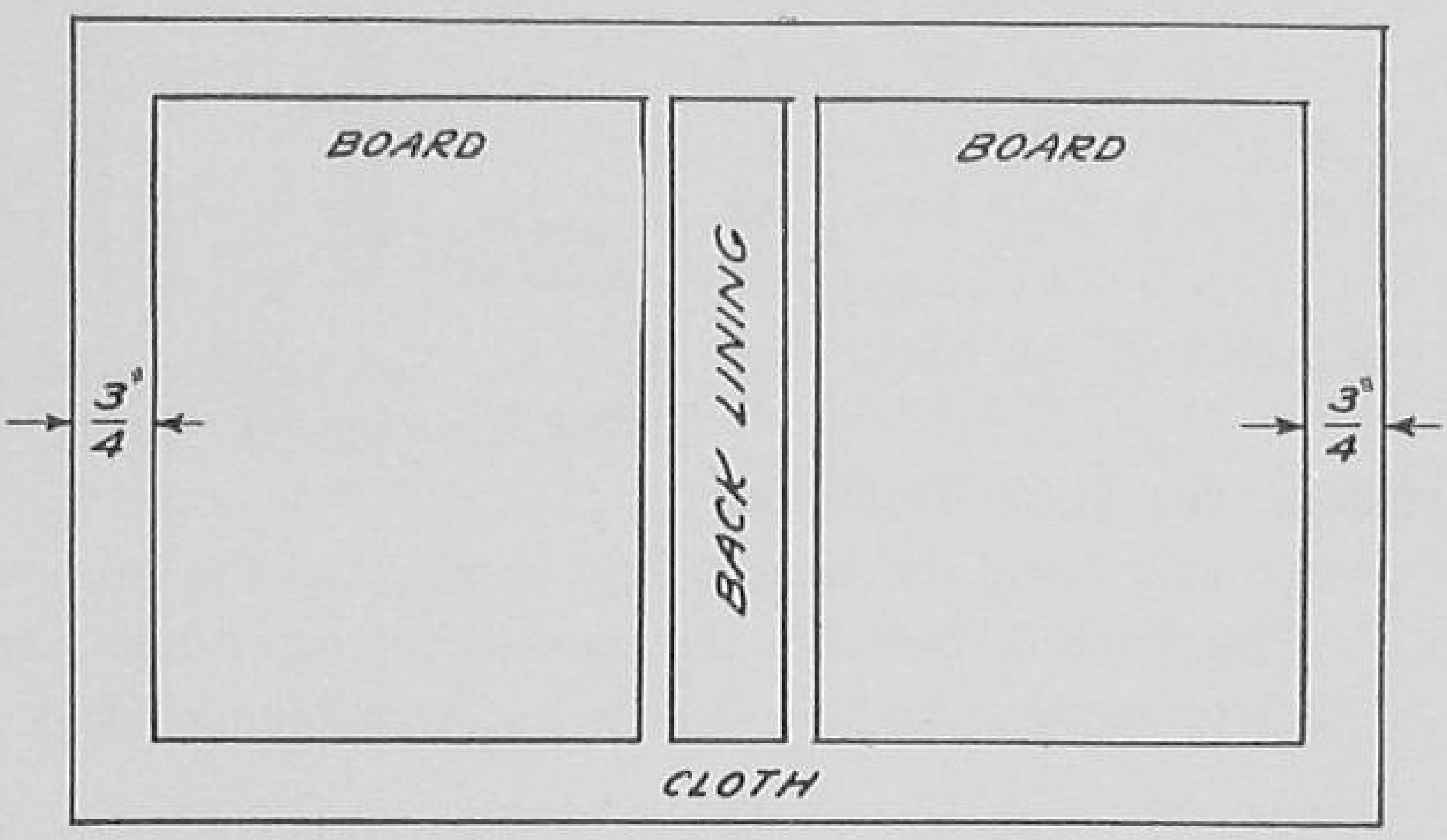


FIG. 80. Laying out the cloth.

Check the accuracy of the angles of your two scribed rectangles with a square. When you are satisfied that all vertical lines and all horizontal ones are respectively parallel, cover the underside of the boards with a thin layer of paste well rubbed into the surface, and lay them down accurately in the marked-out positions. Press them down firmly to adhere them to the cloth.

Forming the Back.

The space of single-thickness cloth between the two boards represents the back of the book. As it is, it would be too limp and weak; it will have to be stiffened and strengthened with a strip of firm paper, such as a piece from a Manila folder. Cut this paper strip the exact length of the case boards and the exact width of the rounded back, from one hinge corner to the other.

Cover the underside of the back lining with paste and attach it to the cloth, lining it up evenly at top and bottom with the edges of the boards and centering it lengthwise between the inner edges of the casings so as to show an equal amount of cloth along its left and right sides. See Fig. 81.

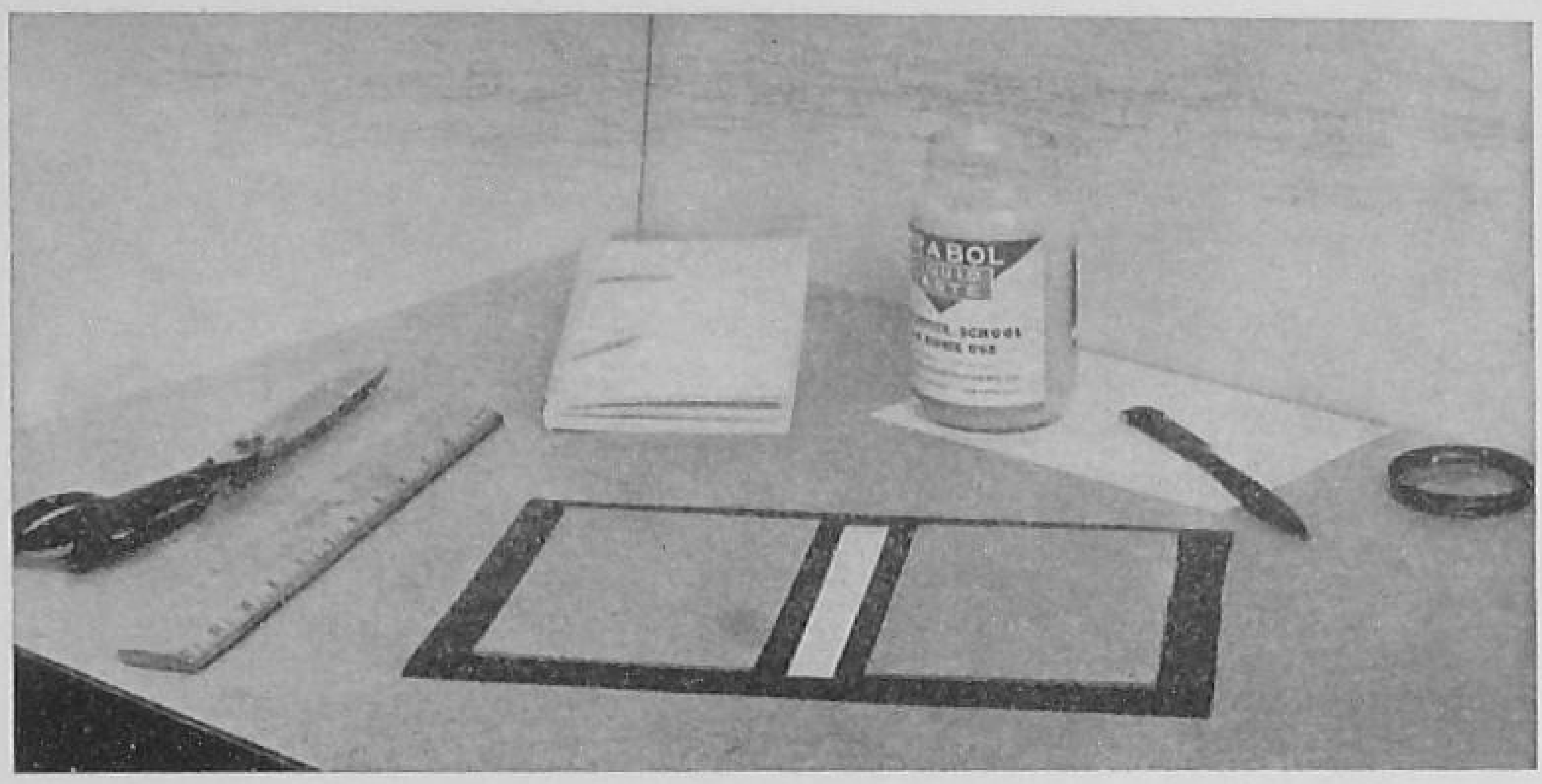


FIG. 81. Making the case.

The grain of this strip of paper also must run the long way. You can determine the direction of the grain in a sheet of paper by folding a scrap piece. If the crease is smooth and even, the grain runs with the fold; if the crease shows cracked and rough, the grain runs the opposite way. See Fig. 82.

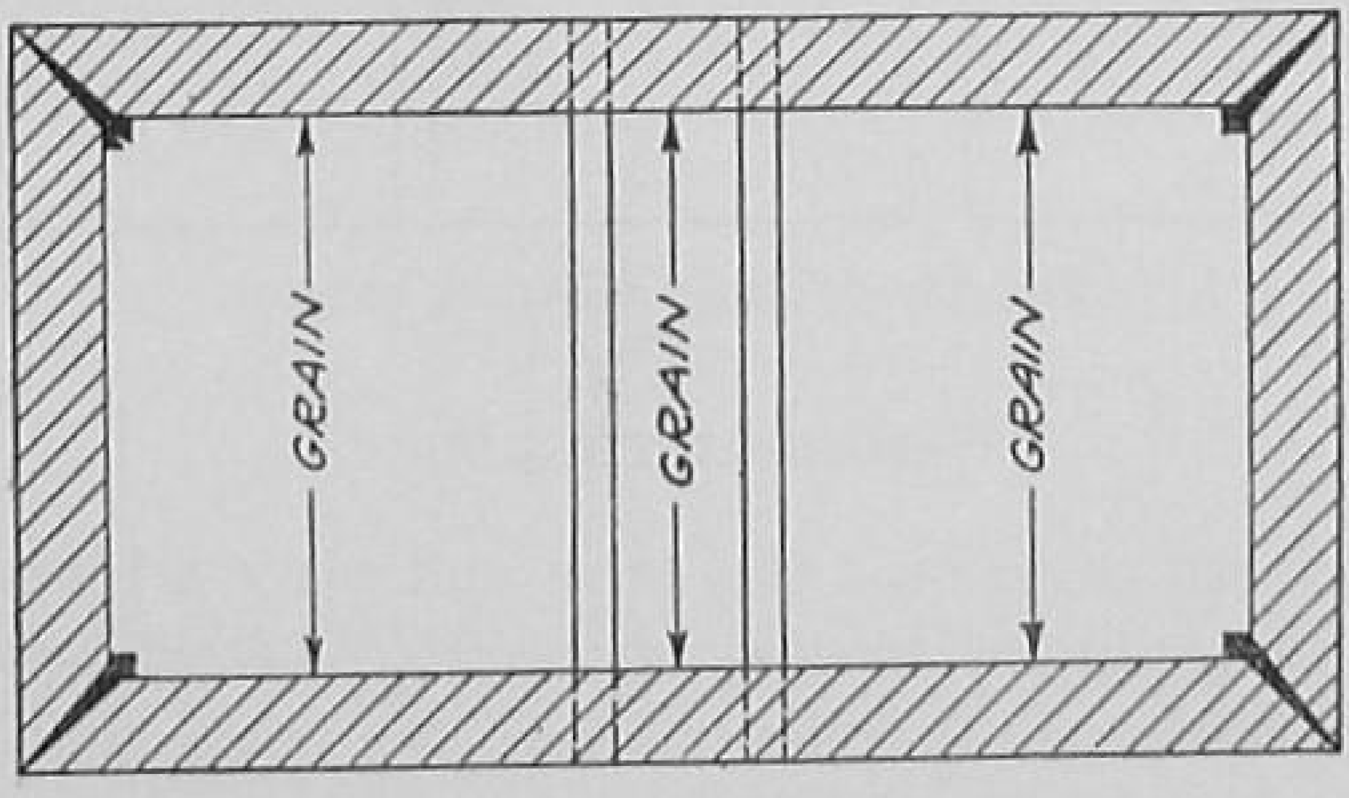


FIG. 82. The finished case.

Now cover the projecting strips of cloth along all four edges of the case with paste and fold the two long ones first over the board, pulling them quite tight, to within an inch or so from the corners.

Shaping the Corners.

There are two methods you may follow in shaping the corners of the book cloth. One is to smooth the cloth all along the cardboard and letting

the 45° flaps meet closely, then snipping the upright flap with a scissors. See Fig. 83. This is the cut or mitered corner. It is of course the simplest, but it does not provide for any reinforcement of the corners, which are naturally exposed to greater wear than the rest of the case. The other is the "library" corner which is constructed according to the three steps illustrated in Fig. 84. It is stronger and longer wearing. Its very name indicates that public libraries, where books are subjected to hardest use, insist on it as the more enduring one.

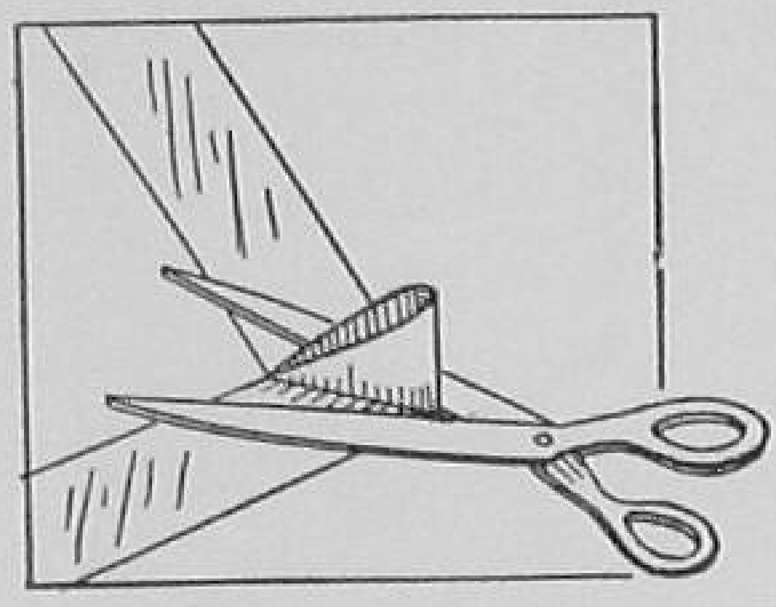


FIG. 83. The cut corner.

Your case is now finished as far as its mechanical construction is concerned. If you intend decorating it by tooling and embossing, this work should be done now while both cloth and boards are still soft and malleable from the moist paste.

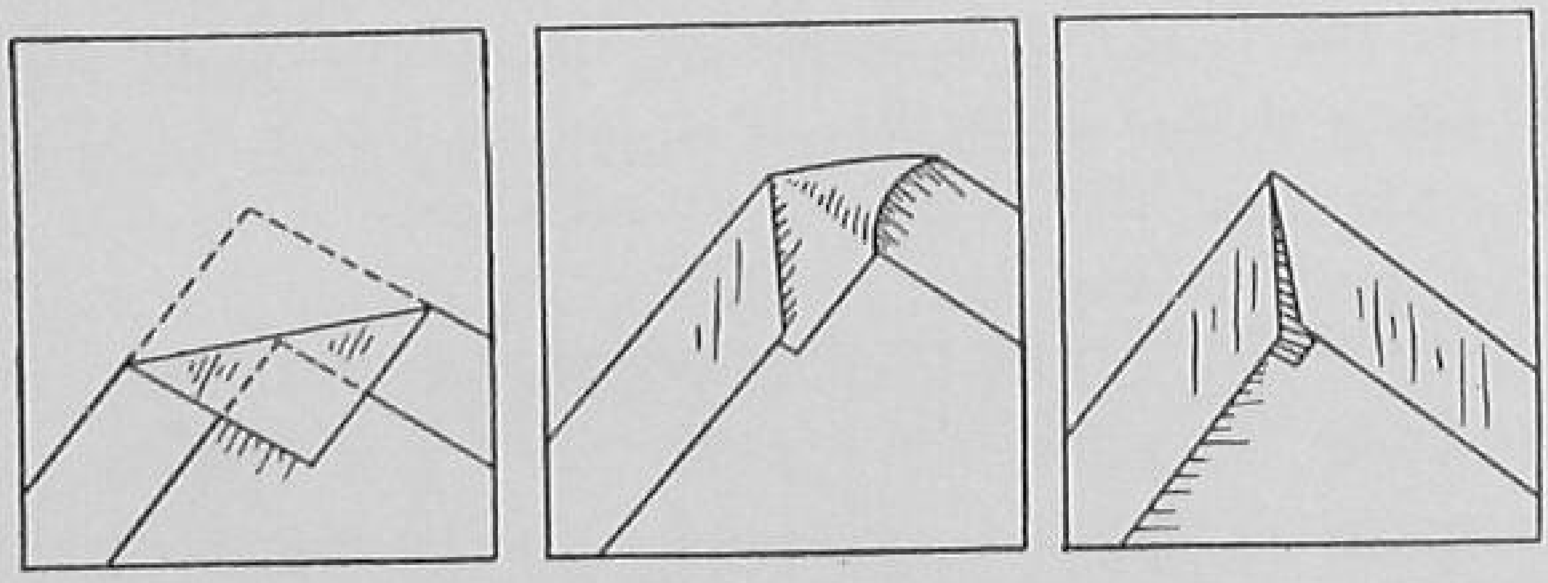


FIG. 84. Making a library corner.

CASING-IN THE BOOK

Lay your finished cover on a flat table and place a block of wood or a weighted box along the inside edge of the left or front cover. Rub paste or flexible glue over one-third the inside of the back cover and to within ¼" of the head and tail edges. Also cover the narrow strip of cloth exposed between the board and the back lining, but do not spread any glue over the latter. With these preparations finished, you are ready to glue your book into its cover. This operation is called the "casing-in" of the book.

Gluing Down Tapes and Super.

Now take up your book and stand it upright on its back, leaning the first page against the wood block or box to steady the book. Center the

back exactly over the Manila back lining strip, allowing equal narrow margins of the folded cover cloth to show at top and bottom. Insert a ¼" thick piece of plywood under the back to bring its level up to the corner of the flared back. First, press the two loose ends of the cotton tape down into the glue, then cover the tapes themselves with some glue and smooth down the loose super cloth over its entire area. Rub the cloth well with a folding bone or your fingertips so as to make it adhere evenly. Allow no wrinkles or folds to form. They would be always visible through the end sheets and mar the appearance of your book.

Gluing Down the End Sheets.

Now spread a thin coat of the same glue or paste over the entire back cover to within ¼" of the three edges. Cover super-cloth, cardboard and the turned-over bookcloth. Insert a sheet of wax paper between the two end sheets. Keeping the last end sheet upright, apply a rim of glue around its three edges about ¼" wide. Use a brush or spread the glue with your fingertips. Fold the end sheet down onto the glued cover and smooth it out well by rubbing it from the inside or back toward the outer edge of the cover. If the first wax paper has been soiled, throw it away and insert a new, clean sheet over the glued-down end sheet. This will protect the rest of the end sheet against glue oozing out from the job just completed and prevent its sticking to the back under the pressure that will soon be applied to the book.

Turn your book around and proceed to glue in the front cover in the same fashion. When finished place a sheet of wax paper between the cover and front end sheet, and carefully close your book. Open it again and check whether the still moist paper has folded with wrinkles in the hinges. If so, smooth them out with a rounded folding bone.

Be extremely neat and circumspect wherever you work with paste or glue. Do not splash it around indiscriminately and have a wet rag always handy to wipe your tools and your fingers.

Shaping the Hinges.

Lay your closed book flat on the table, and with the rounded tip of a bone folder score the still moist cloth down into the groove between the back and the case-boards on both sides of the book. Press slowly and gently at first, and then gradually increase the pressure of your hand on the tool. Leave the two wax papers in their places until the book has been completely finished and dried. See Fig. 85.

Open your clamping press and insert the book into it from the side where the edges are lined with the protruding strips of iron. Fix each of these strips into the scored groove on that side of the book and close the press by slowly and gradually tightening the wing nuts on the four bolts.

Let the book dry overnight at least, and a little longer if you can. The longer it is under pressure the less chance there is of the case warping later on when it is exposed to dry air.

FIG. 85. Shaping the hinges.

Marbleized End Sheets.

A more pleasing appearance can be imparted to your book by pasting in, after drying, a set of decorative end-sheets like those shown in the books in Fig. 87. Marbleizing was invented by the Persians in the middle of the 16th Century, and has been used by American bookbinders for nearly 200 years.

To make these fancy patterned papers, proceed in the following manner: Fill a large, flat pan with about two or three inches of water. In separate, small, tin cups or in paper drinking cups, dissolve a dab of printing ink, each a different color, in about a spoonful of turpentine until the turpentine is well colored with the ink. Place a few drops of each of the colors you want to combine in the water. The colored oil will float on top of the water. With an old comb or a fork, gently move the surface so that the colors float into each other to form a pattern.

Now lay a sheet of your book paper flat on top of the colored water,

and let it float a few seconds. Peel the paper off from two corners, and you will have a multicolored marble-like pattern on the paper. Let it dry, and it will smooth out. See Fig. 86. By choosing a dominant color harmonizing with that of the binding of your book a very pleasing effect can be obtained. Agitating the floating colors will determine more or less the closeness of the whirls which can be regulated almost at will.

Cut the marbleized sheet into two 4-page folders the same size as your

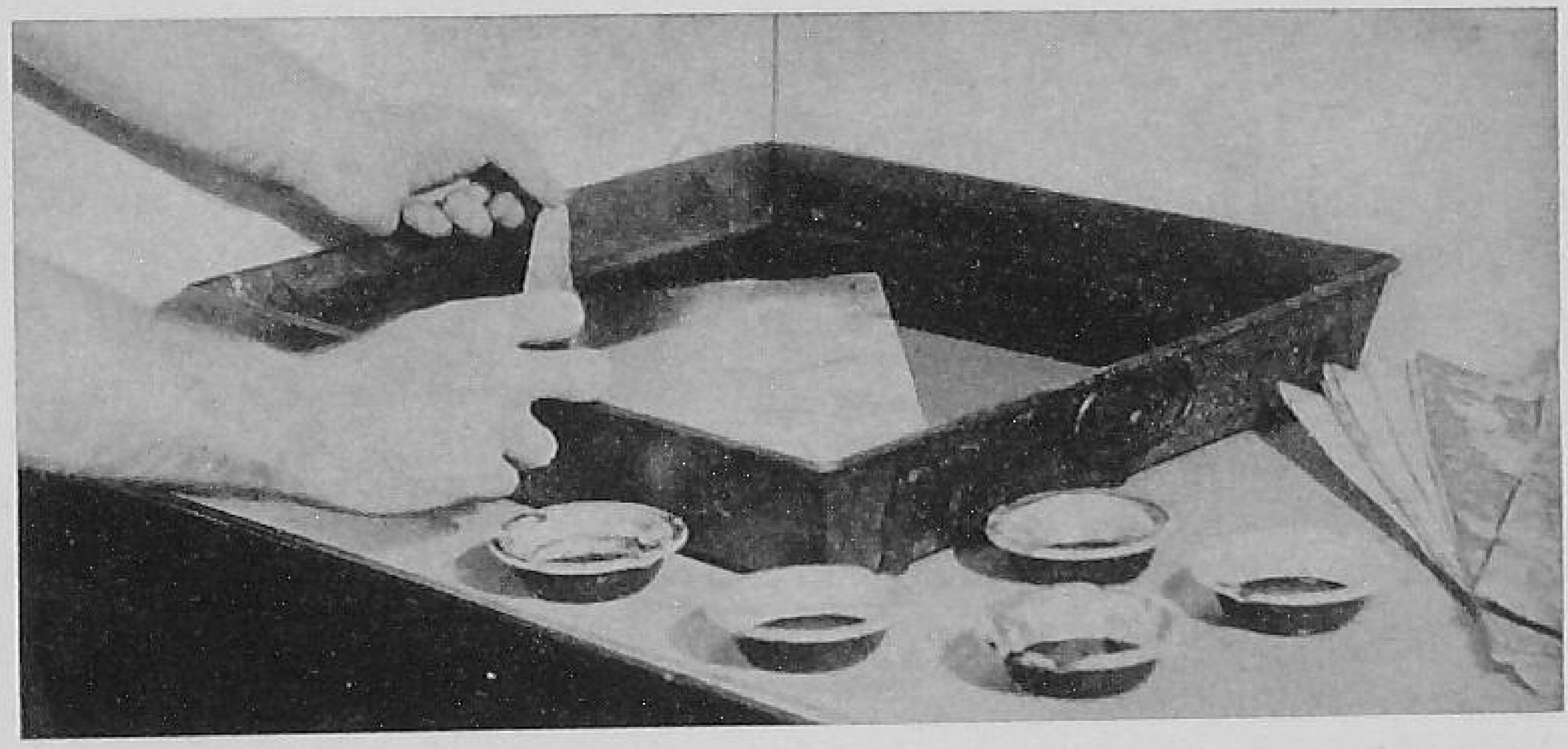


FIG. 86. Marbleizing end sheets.

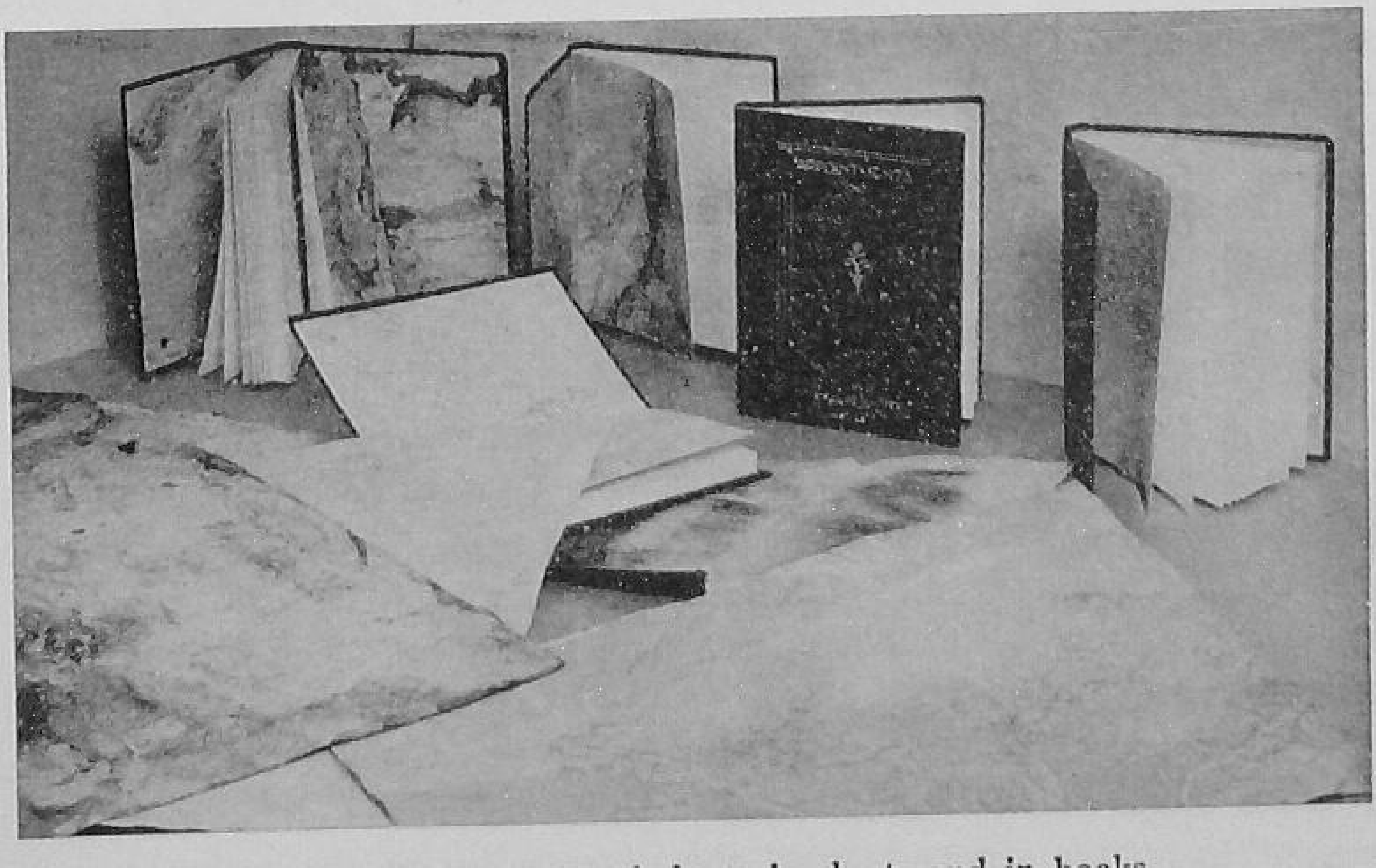


FIG. 87. Marbleized end sheets in sheets and in books.

folded and trimmed book and paste one in front and one in back of the book exactly over the pasted-down, white end-sheets. See Fig. 87. If you have planned for this kind of treatment from the beginning, you may "tip-in" the colored end-sheets to the first and last signature of your book and sew them in with those sections, pasting them down in casing-in.

Decorating the Book

The decorations on a binding are frequently mistaken for the only "art" in the bookbinding craft. It is true that they are more spectacular and, therefore, more likely to attract the attention of the casual beholder. However, no amount of decoration alone will make a book a good one. To have real merit it must have been built with care and integrity of workmanship throughout all the various steps of its construction.

Metal Foil Decoration.

Although gold lettering and elaborate tooling of either leather or cloth bindings are within scope of workmanship of the advanced amateur binder, it is nevertheless true that their practice involves the use of equipment and supplies often too expensive.

Instead, simple and yet pleasing decorations may be applied to home-bound books with an electric pyrographic pen, imitation gold and metal foil of many colors. Such an outfit may be bought from art supply houses for little money. With it, lettering and ornaments of simple design may be applied to the cloth covers and the back by following the simple instructions given with the pen by the manufacturer. It is a process as easy and simple as drawing with a pencil and may be used by some of the youngest students in the school shop.

The binding we have described and the presently recommended method of finishing are simplified substitutes for the traditional, expensive, craft-work artistry exhibited by the master bookbinders. Nonetheless, to those with but limited time and money to devote to their hobby, they offer an opportunity to exercise taste, ingenuity and skill. The student who has mastered the principles and techniques described will be well prepared to branch out gradually into work that more nearly approaches the exacting standards of the older tradition.

In decorating with the less expensive materials recommended, aim at complete simplicity of design in both lettering and line-work. Do not attempt to obtain effects beyond the potentiality of the techniques and

their materials. A candidly simple book that does not pretend to be luxurious can have as much charm and merit as an expensive one. See Fig. 88.

Measure out the areas to be decorated and make a pencil sketch of the proposed lettering and lines. Try them out with your electric pen and foil on a piece of scrap from your binding material. Your initials, your name, or a title such as "Diary," "Notes," etc., and a few single or parallel lines well placed on the back and on the front cover are in keeping with the rest of the blank book you have just completed.

FIG. 88. Decorating the book with a pyrographic pencil and gold or silver foil.

Stained Head.

On de luxe edition books genuine gold or silver leaf is often applied to the head, fore-edge and the tail of the book. Edges thus lined with precious metal are more easily dusted. The custom of staining the head with a harmonizing color stain has been retained in modern machine-made mass editions of books.

The amateur binder may easily apply such a stain to his book. The color is mixed by diluting colored drawing ink with water until the right shade of color is obtained. Insert two sheets of wax paper between the covers and the body of the book, leaving flaps to extend beyond the edges of the cover in order to protect the cover from being accidentally stained. Clamp the book tightly in your clamping press, compressing the pages

closely together so that the stain will not seep onto the pages. Dip a tuft of cotton into the prepared staining liquid and squeeze half dry by pressing it against the side of the dish. Rub the wad over the entire head, from the headband clear to the fore-edge, preferably in a single stroke, and wipe off all surplus stain immediately with a clean, dry cloth. Puddles of stain left on the edge will quickly penetrate the paper fibers and travel down into the white margins of the page heads.

Hand-Tooled Leather Bookbinding

Once the amateur bookbinder has mastered the steps involved in the construction of a book by handcraft, he may want to venture upon the enterprise of binding a book in the manner more nearly approaching the exquisite productions that have come down to us from the hands of the old masters of the craft.

At a time when books were still comparatively rare and costly, they were almost invariably bound in a more durable material: leather. Private collections and museums exhibit many samples of such bookcraft, and the student should not neglect an opportunity of seeing them firsthand. Some are simple and austere in design; others are bound in neatly hand-tooled skins; and still others are intricately decorated in colors and gold leaf, often studded with jewels.

Leather binding, leather tooling and decorating are all much more exacting activities than the working with modern bookcloth previously described. By its very nature leather is more difficult to handle. It is thicker, as a rule, more closely fibered, and very much stronger. It requires much more care and more time for each operation. It is also much more expensive. These factors should all combine to challenge the budding craftsman to do his very best work, devoting to it all the attention, time and thought required to achieve that accuracy and neatness that are necessary in a project of this kind.

All the construction steps are the same for this book as for the one described in the earlier part of this chapter, up to the making of the case. However, in the eagerness to try your hand at leather, do not lose sight of the fact that a satisfactory book must be well built, well sewed, strong and serviceable, as well as beautiful.

Leathers for Bookbinding.

Leather is the tanned hide of animals. As these hides vary in thickness and toughness on the animals, so also the leathers made from them vary.

Only the softer and thinner leathers are suitable for bookbinding. Sheepskin or "vellum" is the strongest and most enduring. Calfskin is somewhat thicker but lends itself admirably to tooling work. Both of these leathers are rather expensive. Goatskin has been the most commonly used material for hand bookbinding since the days of the medieval Moors; it is better known today under the name of "Morocco."

Once in a while more fancy leathers such as seal, alligator, snake or lizard are used for the binding of books whose text content has some relation to those animals themselves, their natural geographical habitat, or some other association of ideas connected with them. It is one of the subtle advantages of the craft to be able to relate binding and content in some such suggestive way: One man bound Adolf Hitler's *Mein Kampf* in skunk skin with the hair left on.

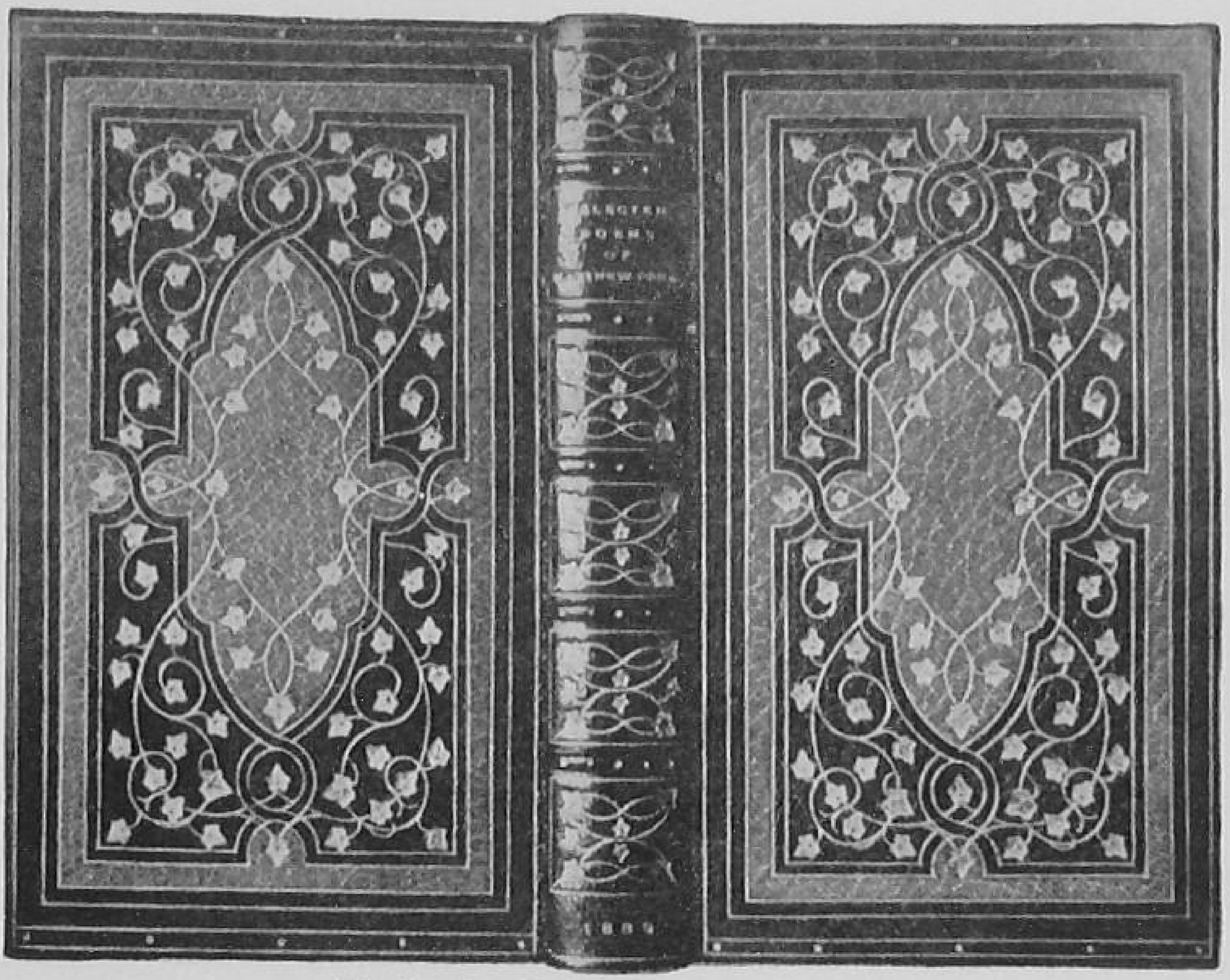
Leather has a grain side—through which the hair or bristles protruded before the hide was tanned—and a flesh side. The grain side is commonly the smoother of the two. Unless there are specific reasons to depart from common practice, the grain side is the "good" side, and the flesh side is the one pasted on the boards of the book.

The grain itself may be the natural grain for that particular kind of leather, or the grain pattern of a more expensive leather may have been impressed on a cheaper grade of skin or on "split" leather. Skins of this latter type should not be used for your best work. Pretending to be what they are not, they lack one of the essential qualities of best craftwork and its materials: complete honesty and genuineness.

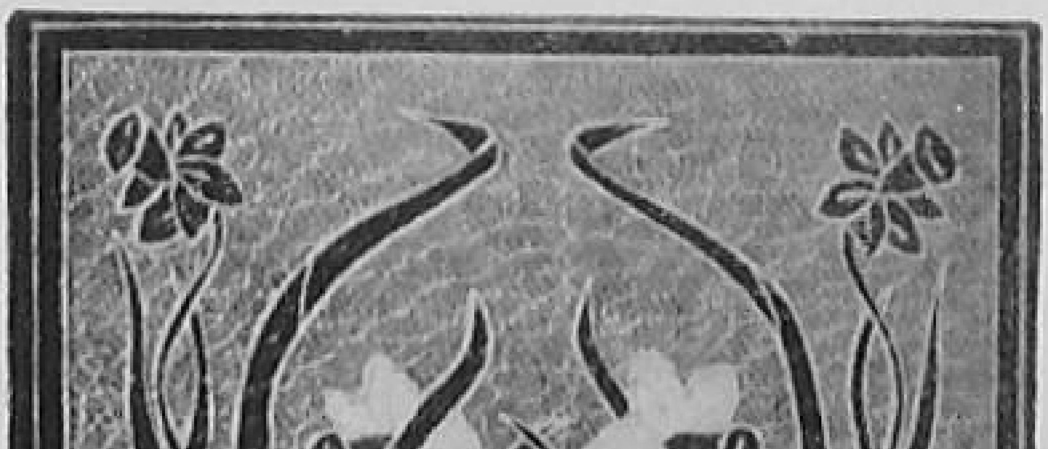
Leather may be bought from bindery supply houses by the square foot or by the whole skin. The size of the skins, of course, varies with the size of the animals themselves, the average being from about eight to twelve square feet. Some supply houses issue cards with samples of their leathers attached, showing grains, colors and average thickness available. The serious craftsman should have these swatches in his files. Whenever a book is to be bound, the question of whether or not the same material for other books in the series will be available should be given consideration.

Making the Leather Case.

All the construction steps are the same for the leather-bound book as for the one described in the earlier part of this chapter. The book is sewed, trimmed, rounded, and supered in exactly the same manner as the one prepared for the cloth-binding. This method provides for a tape-sewed, hollow-backed book.



Binding by Ralph Randolph Adams.



Doulblure of Binding by Ralph Randolph Adams.

Fig. 89.

Most of the old-time books were sewed around stout round cords, which were left to protrude across and beyond the surface of the back. The cover boards were attached to these cords, and the final leather covering was drawn tightly over the whole book. The protruding cord ridges remained visible and provided convenient panels for the lettering and decorating of the back. Fig. 89 shows bindings of this type. European, especially English artists, still recommend this kind of construction for hand-binding in leather. Some bibliographical references are appended to this chapter for the benefit of the student who wishes to investigate further this manner of binding.

Cutting the Leather.

Lay the whole skin, flesh side up, on a flat, wooden surface and mark out the outline of the piece required for the case, using a ruler and a scriber or a well-sharpened pencil. In the same manner mark out the entire outline of the spaced boards. In most skins the grain of the leather is closer

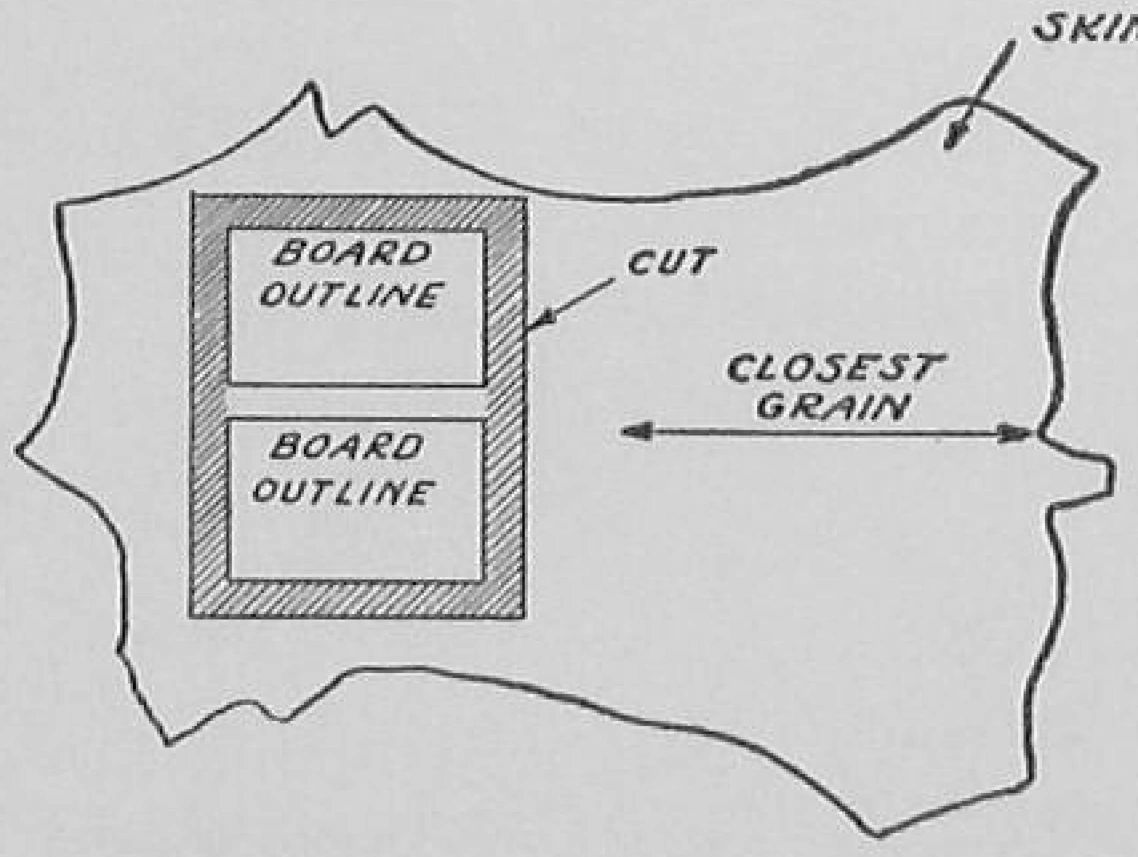


FIG. 90. Shaded area marks turn-in margins and back that will have to be thinned down by paring.

and firmer down the back of the skin from the neck to the tail end of the hide. The cutting should be arranged, whenever possible, so that the head-to-tail direction of the book runs this same way. See Fig. 90. Allow a generous margin around the boards, at least three-quarters of an inch each way. This wide turn-in will give your book a richer appearance and provide a frame for inside cover decoration or doublure.

The actual cutting is done with a metal straightedge and a very sharp knife or with stout sharp shears. If the knife is used, turn the skin so that

each successive cut is made across the grain of the wood support below the leather in order to avoid the tendency of the knife to follow the grain formation of the board. See Fig. 91.

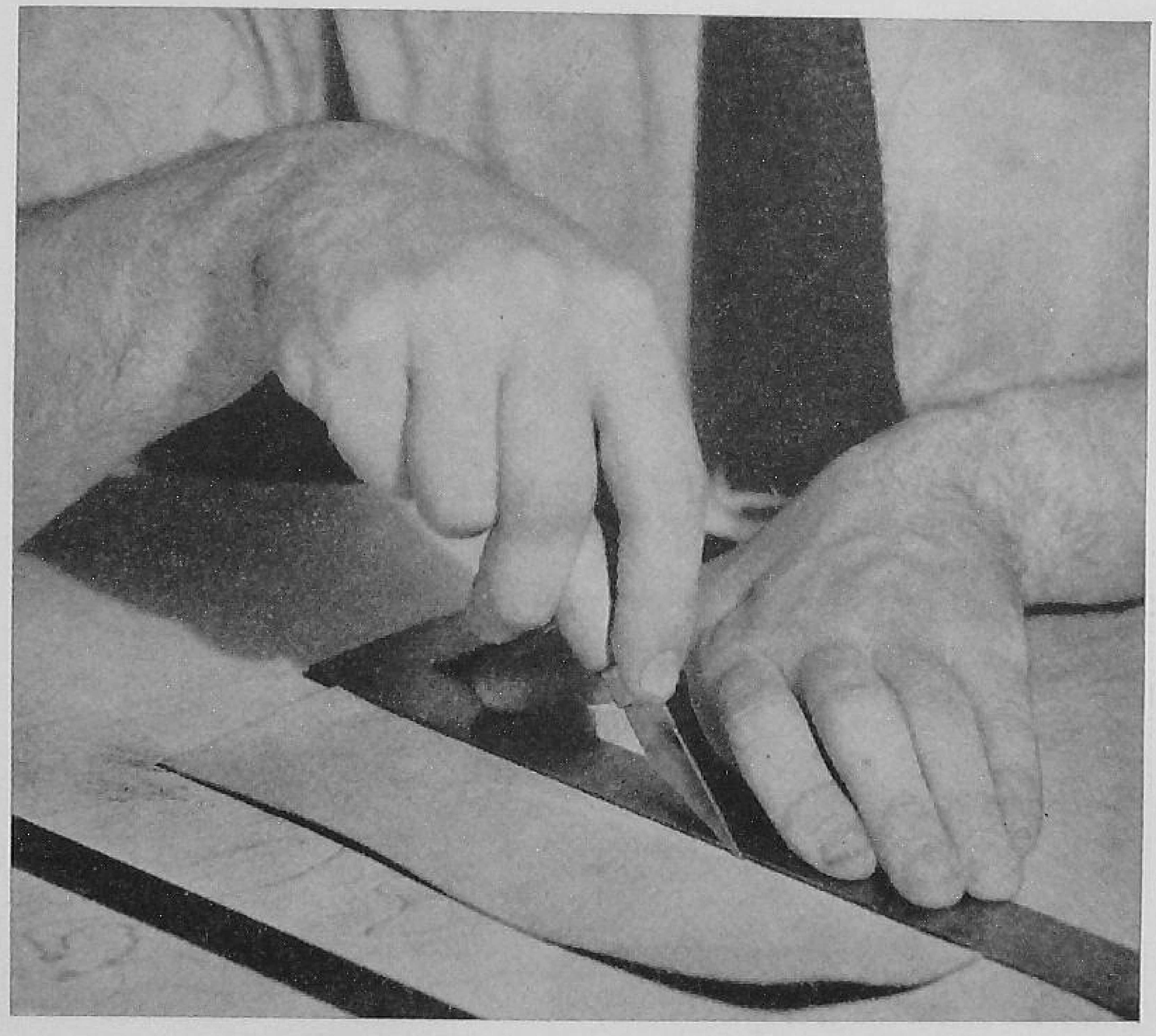


FIG. 91. Cutting leather with a knife and metal straight edge.

Paring the Leather.

Paring means shaving or thinning the leather from the flesh side so as to render it more pliable and flexible for the turning in of the edges over the boards. The amount of this work required depends, of course, on the thickness and the nature of the leather. In most cases it will have to be done only in the areas shown in shading on the cutting diagram in Fig. 90, that is, from just inside the board markings to the edges and down the back, where the hinges will be formed.

Paring is done with a skiving knife, sharpened and beveled on one side only. Fig. 92 shows such a knife. The leather is laid over a perfectly smooth, hard, and level surface, such as a slab of heavy plate glass or a discarded litho stone. Great care must be taken that no shavings and fuzz get under the skin while cutting. Even the slightest eruption may result in cutting a hole in the leather. The pared surface must be perfectly even or else the binding will show ridges when drawn over the boards. Fig. 93 illustrates the manner of using the paring knife.

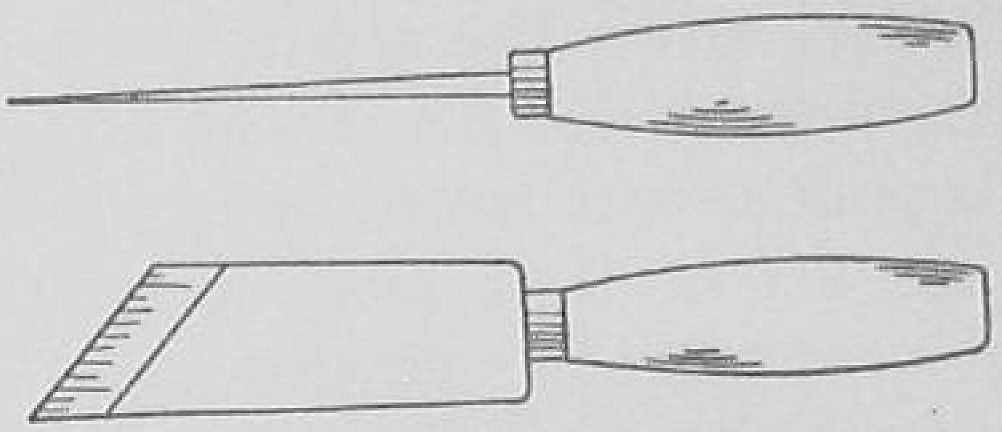


FIG. 92. Skiving knife.

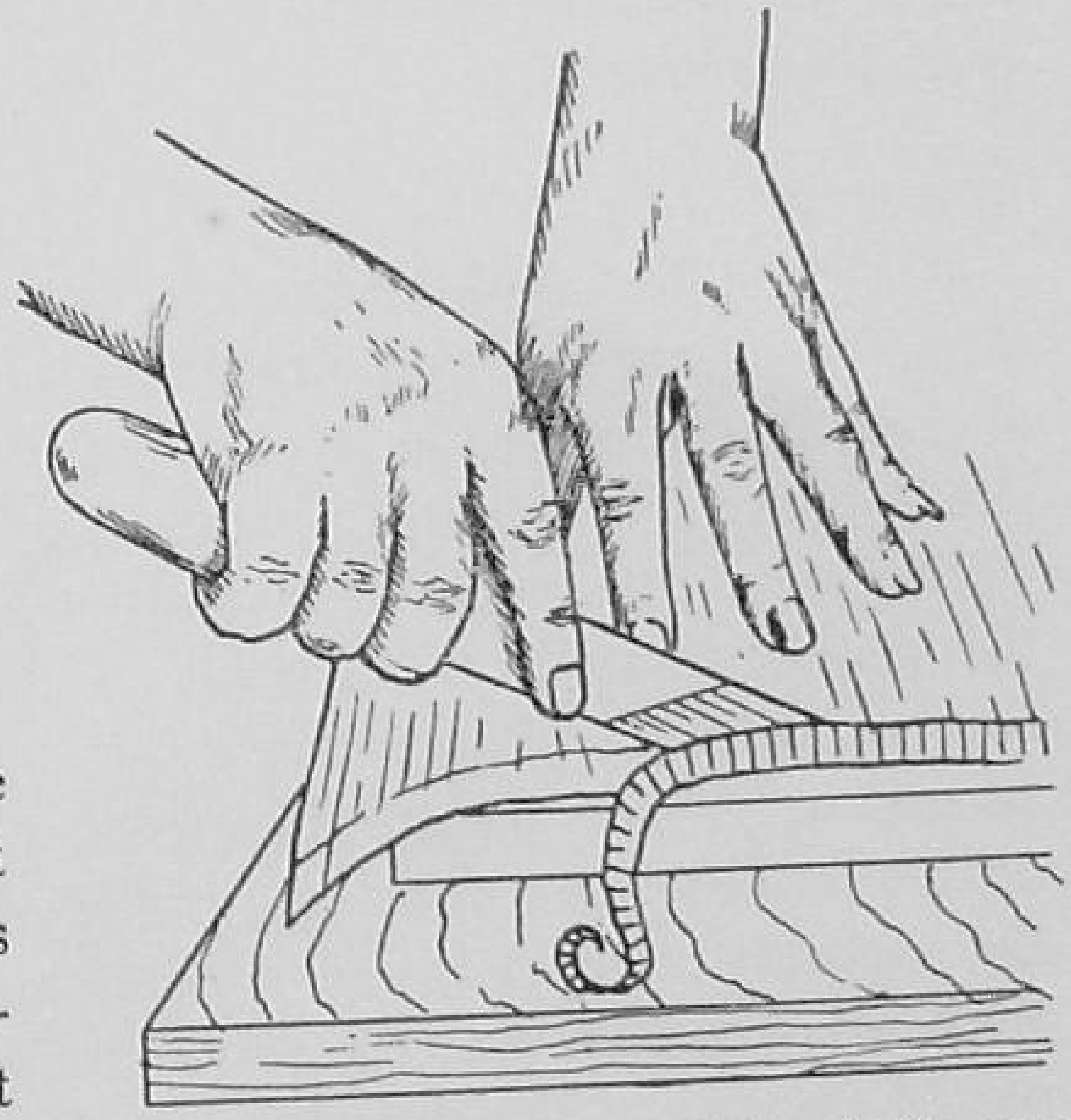


FIG. 93. Paring with a skiving knife on a plate glass slab.

Shaping the Corners.

The turn-in margins must be mitered at all four corners. Not even the thinnest leather allows for the making of the library corners described above. At a point exactly the thickness of the board used from the corner of the board, mark off each corner at an accurate 45-degree angle, as shown in Fig. 94. Cut the leather along this line and slightly pare the edge so obtained. A protractor or a reliable 45-degree triangle must be used for this operation. If accurately done the corners will meet exactly and be quite flat after being rubbed down with a bone folder.

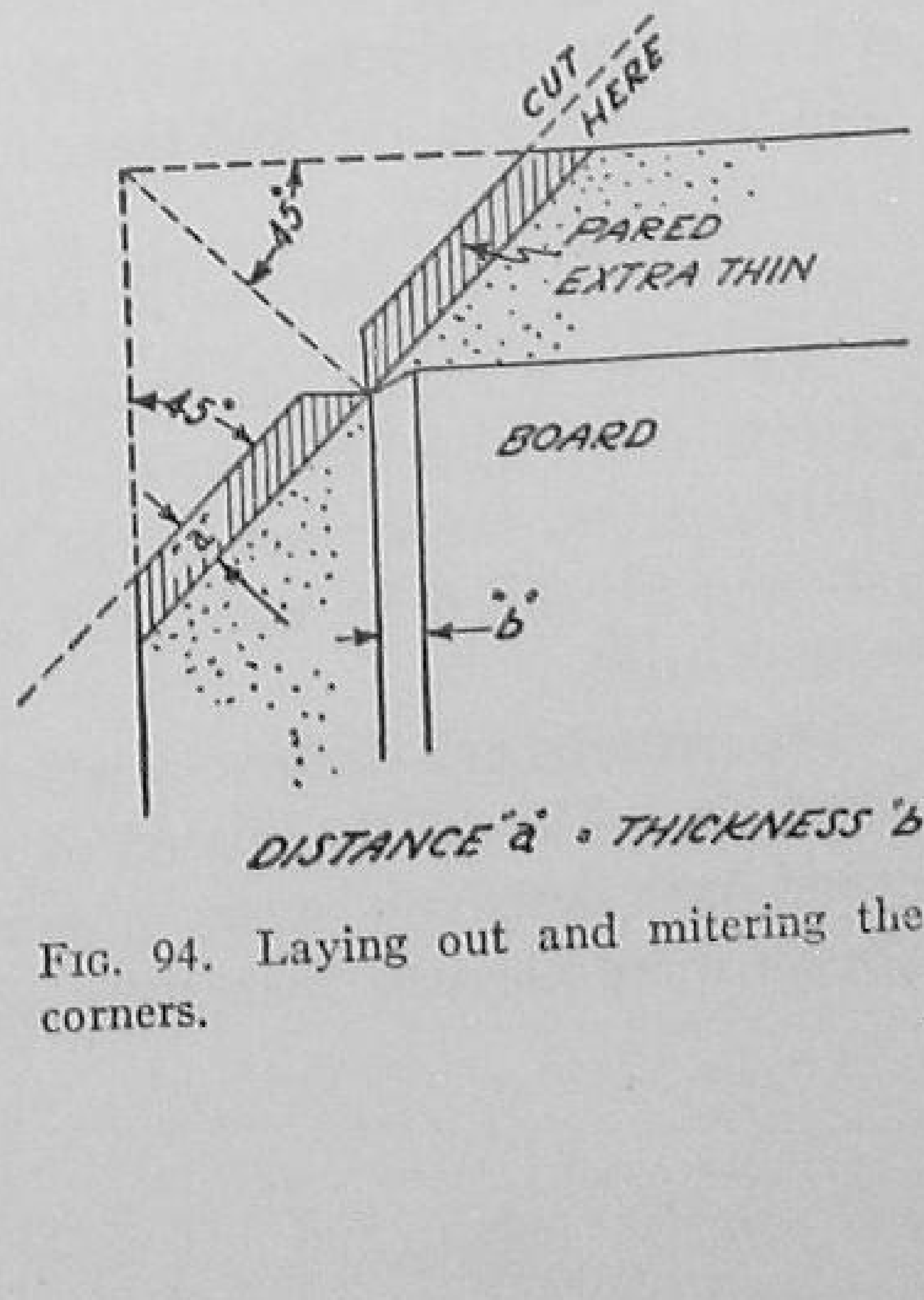


FIG. 94. Laying out and mitering the corners.

Pasting the Cover.

Your leather is now ready to be pasted up with the boards and the

backing strip. Use a good grade of library paste and rub this well into the flesh side of the leather with your fingertips. Let the leather lie an hour or so with the paste on so that the moisture of the paste will penetrate and render it quite supple. Rub some more paste on the leather and proceed to make your case as described previously. Using a bone folder, remove all excess paste as it is squeezed out from under the edges of the leather or the miters at the corners. While the leather is moist with the paste, do not touch it with any iron or steel tools. The tanning acids left in the skin will turn into black stains upon contact with iron, and these cannot be removed.

Casing-in.

It is best to case-in your book while the cover is still moist. Before clamping it in the drying press, a sheet of heavy paper should be cut to fill exactly the rectangle left beyond the turned-in leather border on the inside covers. This paper should be the same thickness as the pared leather edges and pasted in so as to bring the whole inside of the cover to the same level surface. In many of the better bindings these sheets are covered with a suitable fabric such as silk, and are then known as "doublures." The pasting in of these doublures at this point serves a double purpose: It finishes the inside of the cover and, at the same time, the moisture applied inside counteracts the tendency of the boards to warp, when wet on one side only. Remember to insert paper between the pasted covers and the end sheets of the book. You cannot apply as much pressure on this book as on the cloth-bound one while setting it to dry. If the drying press is screwed up too hard on the pliable leather, the fine grain pattern might be destroyed. So bring the press up just enough to hold the book straight, and leave it at least twelve hours to dry.

Finishing the Leather Binding

The term "finishing" is applied to the lettering and ornamentation applied to the leather to complete the binding. Such decorations are either impressed into the surface of the leather by blind-tooling or they may be subsequently filled in with gold leaf to make a rich contrast with the leather itself.

The patterns and designs in which these elements of decoration are combined should be subtly related to the content of the book. As a guiding principle in designing covers, it should be borne in mind that simplicity is always more pleasing than mere accumulation of lines and figures. Any

attempt at pictorial representation should be abandoned. Lettering should always be regarded as part of the design. Nor are many elaborate tools required. The beginner can do very good work with only a few letters and stamps. As his interest widens and specific requirements dictate, he will no doubt add to his stock.

Finishing Tools.

A modelling tool of the type illustrated in Fig. 95 with one narrow end for line work and tracing and the other end spoon-shaped for modelling.

Hand stamps made of brass and which may be bought ready made, or the designs can be filed, drilled or ground into the end of a brass rod.

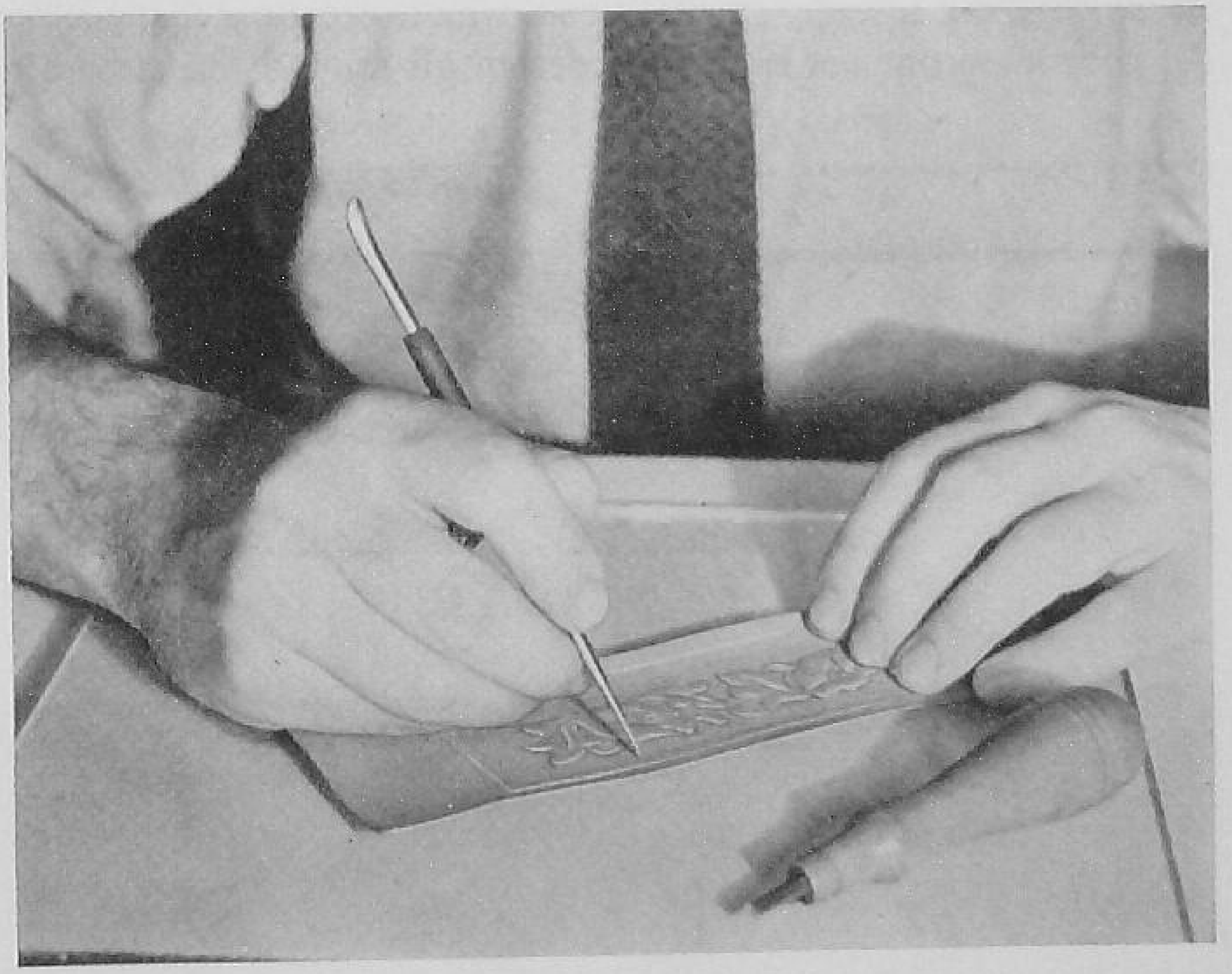


FIG. 95.

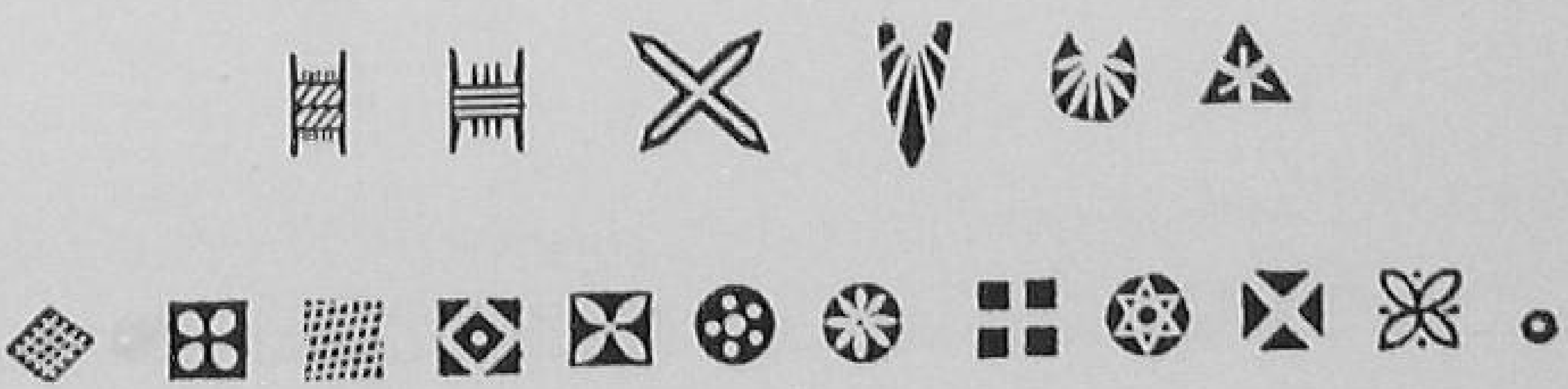


FIG. 96. Background stamps.

Fig. 96 shows some suggestions for such stamps. Whether bought or homemade, these stamps should be fitted into wooden file handles. The ends bearing the design must be slightly heated for our work; without the handles they might burn your fingers.

For lettering-in the back and the title a set of brass type stamps is required. Bookbinders' supply houses carry such type in stock. The letters may be brazed to brass or steel rods and fitted into individual handles the same as the stamps above, or a pallet may be obtained in which several letters can be set up, heated and struck in together. A conservative simple type design is much more serviceable than any fancy face that could be used for very limited work only. A simple Roman or block letter design may be used for most books.

Line and border wheels, small wheels which are interchangeable on a handle, with a continuous embossing design all around the circumference,

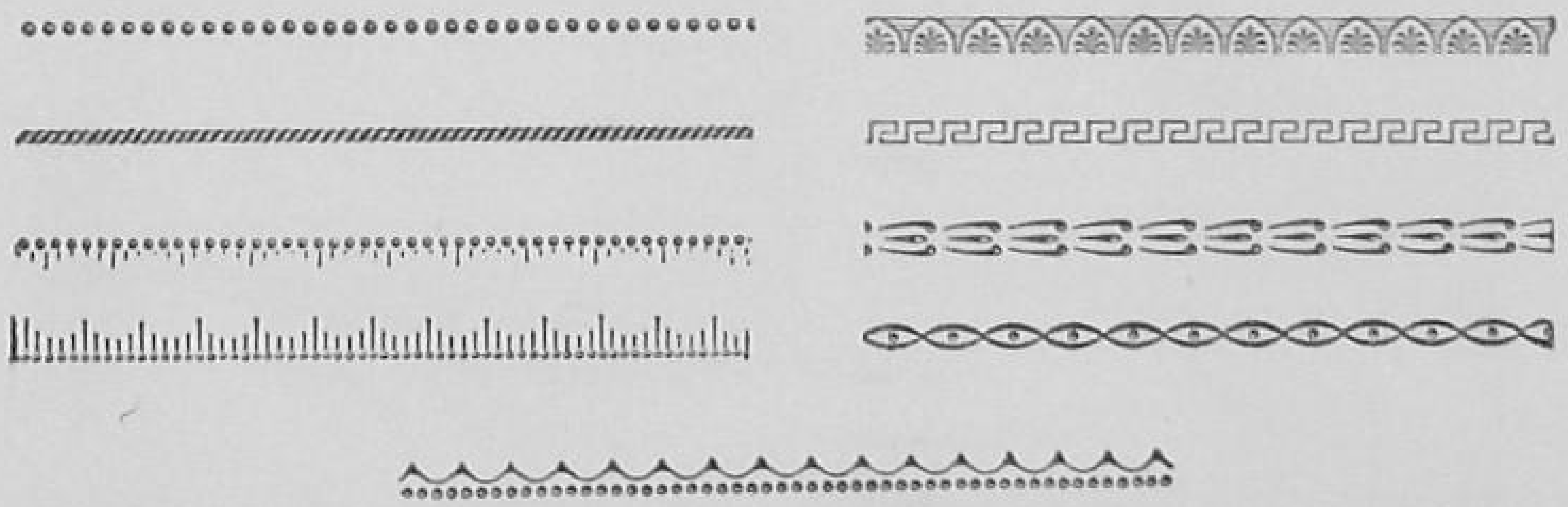


Fig. 97. Wheels.

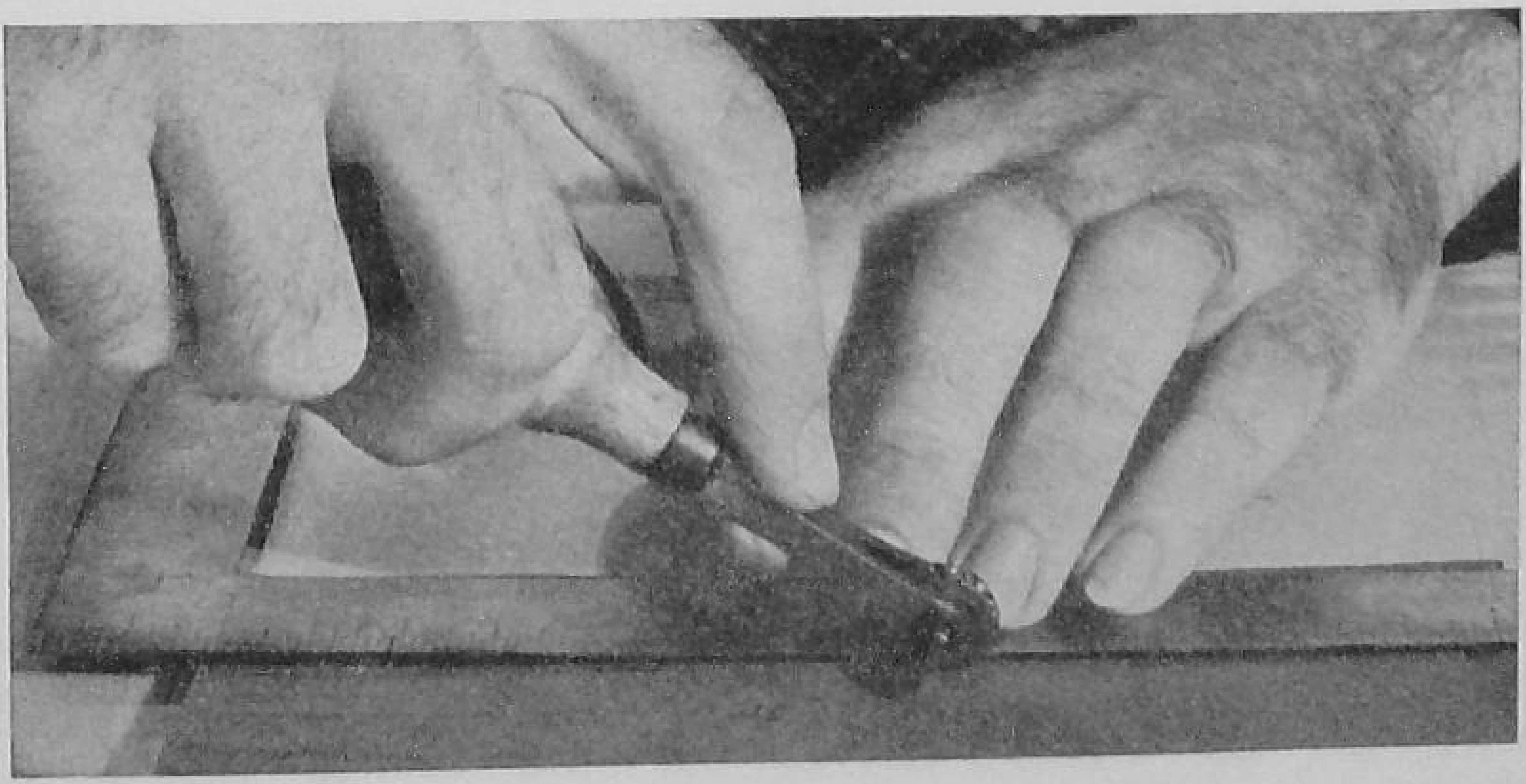


Fig. 98.

are used for making decorative borders and lines demarking panels on the leather. Fig. 97 shows some of the commonly available border designs and Fig. 98 illustrates the manner of using the wheel.

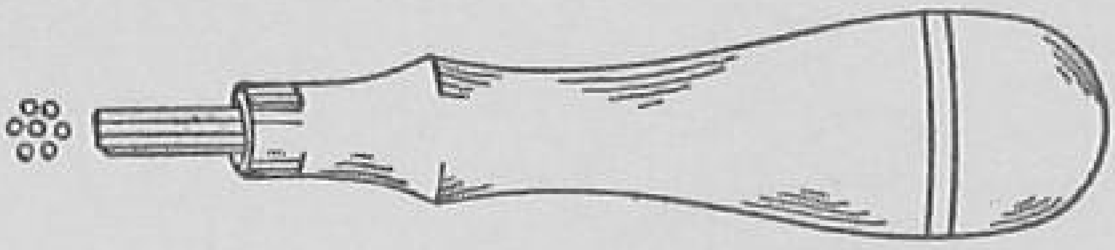


FIG. 99. Background stippler.

A background stippler for stippling or dotting background areas to give contrast in surfaces. It can be made at home by fitting seven blunted pins into a handle to form a design like the one illustrated in Fig. 99.

A small gas plate or an electric stove for heating the ends of the finishing tools. A provision should be made so that the tools can be disposed on the heating surface in a circular arrangement as suggested in the diagram in Fig. 100. A circular wire rest with niches for the individual tools works very well and may be made to fit the particular stove in use.

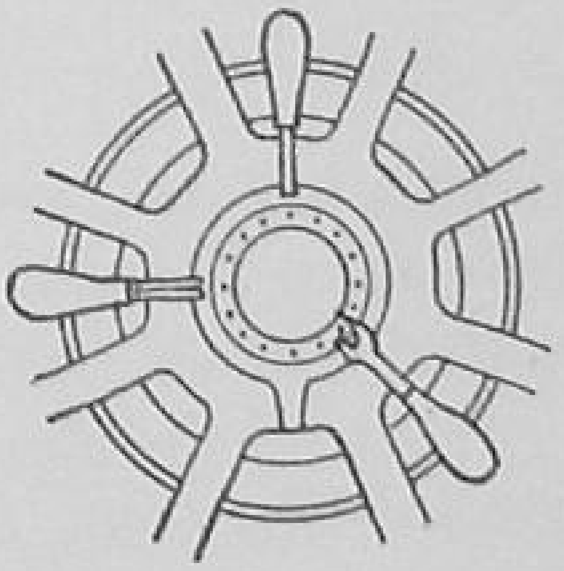


FIG. 100. Gas plate with tools arranged so that only the tips are heated.

Blind Tooling the Leather Cover.

The Guide Sheet. The complete design to be worked into the leather should be drawn out on a thin, strong sheet of paper with a pencil. The various stamps and letters can be inked on a rubber stamp pad and struck in so that all proportions are obtained quite accurately. This is your guide sheet.

Striking the Tools. The guide sheet is attached over the leather so that every part of the design is in its correct place. The tools needed are disposed around the source of heat and warmed just enough so that when they are touched to a wet cloth they barely hiss. A wad of wet cotton in a saucer serves well for this purpose. The tip of the warm tool is then fitted accurately over its ink impression on the guide sheet and the tool is pressed down smartly with the right hand, the thumb pressing on the end of the handle as shown in Fig. 101. If you are in doubt as to the degree of heat required for your particular kind of leather, use some of the scraps from the cutting of the skin and experiment on them to get the feel of the tool and stroke.

Smaller tools need less pressure, whereas the larger ones may require the full weight of the body. It is not necessary to rest the tool long on the leather. A quick, sharp impression usually gives the best results. Some-

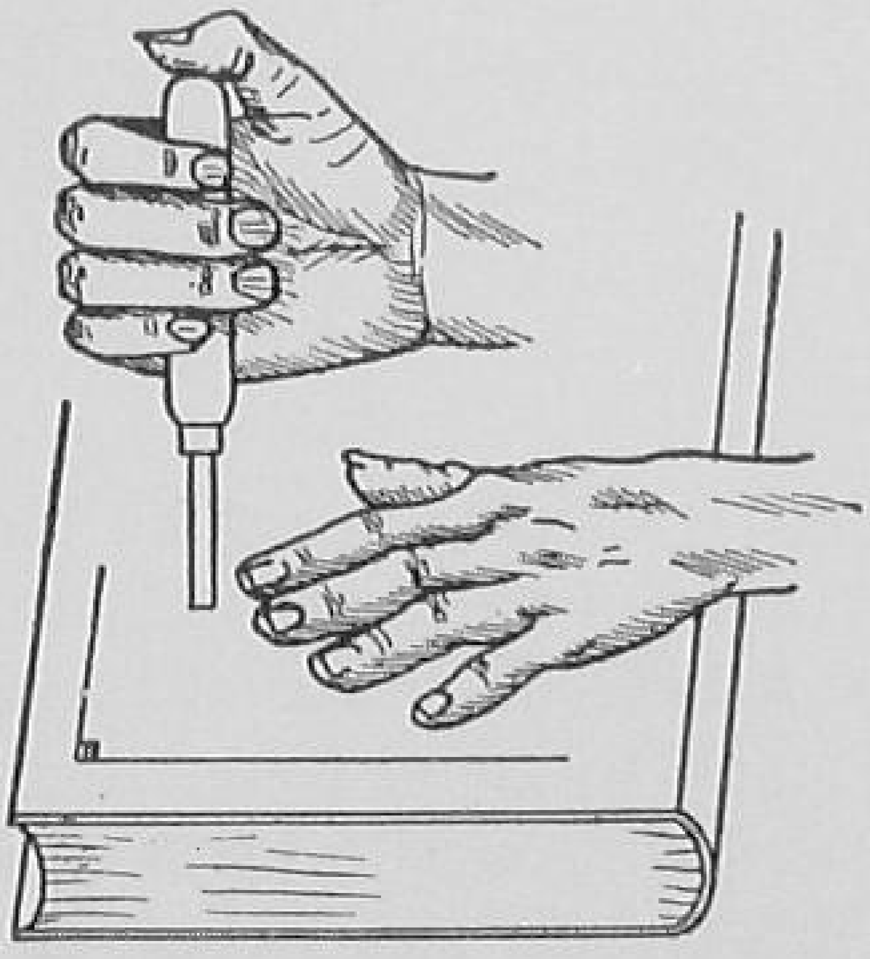


FIG. 101. Striking the hot tool.

times a tool may have to be struck in a second time. Great care must then be exercised to align it properly or else a double impression will be made with disastrous results.

When all the elements of the proposed design have thus been struck in through the guide sheet, remove the latter and go over the whole cover again with the tools slightly hotter than the first time. Rock each tool slightly while striking it in, so as to glaze and polish the bottom of its imprint in the leather.

Gold Tooling.

When the blind-tooled work is to be filled in with genuine gold leaf, all the small impressions at this stage must be painted in with an albuminous sizing called *glaire* and a fine artist's brush. Glaire can be bought in powder form and dissolved in water or it can be made in your kitchen by beating up the white of an egg with a little malt vinegar. Paint only the bottom of each impression, and before it dries completely lay a small piece of gold leaf over the part and strike the hot tool once more in the depression. Here, too, great care is necessary to fit each of the tools back in its corresponding depression. It is very difficult to do this consistently, but the student can, with practice and perseverance, achieve satisfactory results.

Gold leaf is sold in small books. It is lifted and laid down with a pad of cotton slightly greased by rubbing it over your hair.

When all the design has been gilded, the surplus gold adhering to the edges of the stamp marks is cleaned off with a gold rubber especially made for the purpose and which may be bought along with the gold leaf.

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Plastic Arts Crafts Section

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INTRODUCTION TO PLASTIC ARTS CRAFTS SECTION

The work presented in this Section is treated from the viewpoint of the beginner in craft work. Fundamental processes are explained simply and clearly with the aid of many action-type pictures. In one important respect the procedure deviates from the more or less "standard" method of presenting such material. Instead of explaining materials, tools, and processes in separate chapters, the treatment here brings to the attention of the craftsman all the information that he needs at the time he has need for it. The use of tools and the characteristics of materials are introduced briefly as the explanation of the processes relate to them. In this manner the beginner is helped over the otherwise "blank spots" which may naturally result from his inexperience.

Four basic projects have been described in much detail in Chapters V through VIII. These projects were selected to include the most fundamental plastic craft processes. Any one of them will provide a good starting point for the beginner, after which he may go on to more advanced types of work. The author has purposely avoided limitations in choosing designs and dimensions. Much of the joy and satisfaction of craft work are lost when the object produced is merely a reproduction of another's plans. Rather, the fundamental idea upon which this section is built is to present the prospective craftsman with sufficient knowledge of tools, materials, and processes to allow him to bring into play his own originality, talent, and initiative. The more advanced processes are fully discussed in a separate section to which ready reference may be made. A few typical projects, utilizing these advanced techniques, have been included.

An effort has been made to present the material in a form that will convince the prospective craftsman that the possibilities of success are well within his grasp. Too often great talent in this realm is left uncovered because an individual feels absolutely incapable of developing his ideas when confronted with the many unfamiliar tools which are necessary in a new craft. No claim is made for originality of processes or of projects. Instead, the author has endeavored to incorporate in this Section techniques of teaching that have proved successful over many years of experience.

VI. PLASTIC ARTS CRAFTS

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Chapter I
WHAT ARE PLASTICS?

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Chapter II
PLASTICS USED IN CRAFT WORK

•

Chapter III
SOURCES OF MATERIALS AND SUPPLIES

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Chapter IV
INTRODUCTION: HOW TO WORK WITH PLASTICS

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Chapter V
PLASTIC PAPER KNIFE

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Chapter VI
PLASTIC RING

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Chapter VII
PLASTIC BRACELET

Chapter VIII
PLASTIC POWDER BOX

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Chapter IX
SOME ADVANCED TECHNIQUES

•

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TYPICAL PROJECTS

Chapter I

WHAT ARE PLASTICS?

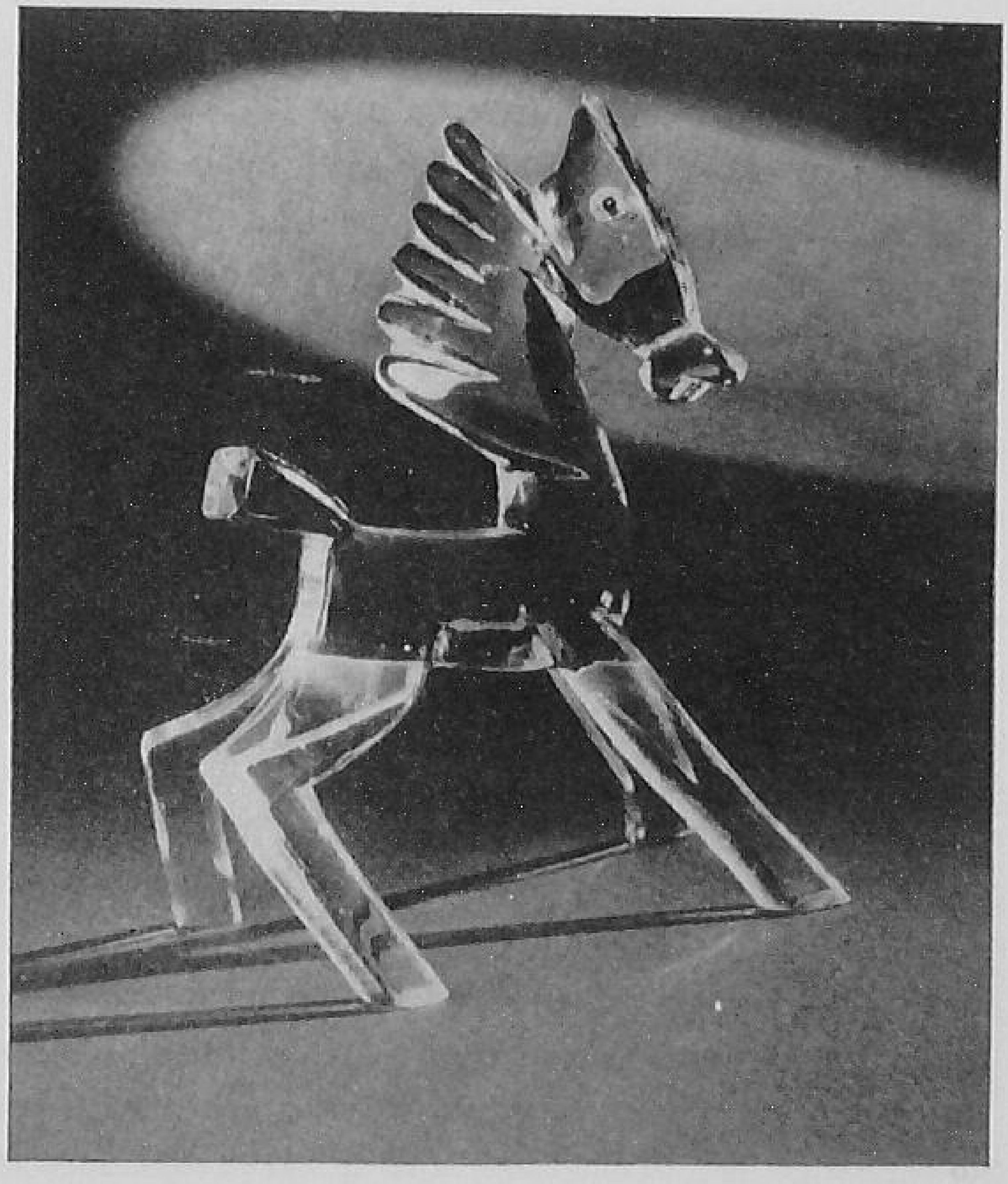
Plastic materials have been known and used almost since the dawn of history. Bricks, tablets, and many other antique specimens have been discovered which seem to show that man has ever been adept in using the materials available to him in the molding of useful and ornamental objects. Natural plastic materials—such as pitch, rosin, tar, amber, shellac, and rubber—have been very useful in past civilization and still have important applications in the modern industrial world. The natural resins of vegetable origin are obtained from trees that grow in many different parts of the world. In most cases the gummy resin that seeps from a wound in the tree bark is gathered and then treated so that a solid or semisolid plastic material results. There are also many natural resins of mineral origin, typical of which are asphalt, pitch, and tar. In most cases, substances like asbestos and mica are mixed with the mineral resins, and under the influence of heat and pressure the so-called "cold-molded plastics" are created.

The search for moldable materials has been a driving force in the experimentation of countless numbers of scientists. This research has culminated in one of the triumphs of modern chemistry—the new group of materials called "plastics." Today the chemist's ability to improve on Nature's products is taken for granted. From comparatively simple substances like carbon, air, and water he creates new and wonderfully useful products that are free from many of the limitations and adverse characteristics of the natural products which they replace.

According to the dictionary the term "plastics" means "anything that can be molded." The present-day group of man-made plastics, however, cannot be defined in such simple words. Today the term is applied to a great variety of synthetic materials derived from an ever-expanding array of chemicals and chemical processes. No one definition seems adequate to describe fully the wide range of chemical compounds included in the new commercially adopted meaning of the term "plastics." A generally accepted definition for a plastic may be found in the booklet, "Plastics," published by The Society of the Plastics Industry, Inc., as follows: "Any one of a

large and varied group of materials which consists of, or contains as an essential ingredient, an organic substance of large molecular weight and which, while solid in the finished stage, at some stage in its manufacture has been or can be formed into various shapes by flow, usually through application singly or together of heat and pressure."

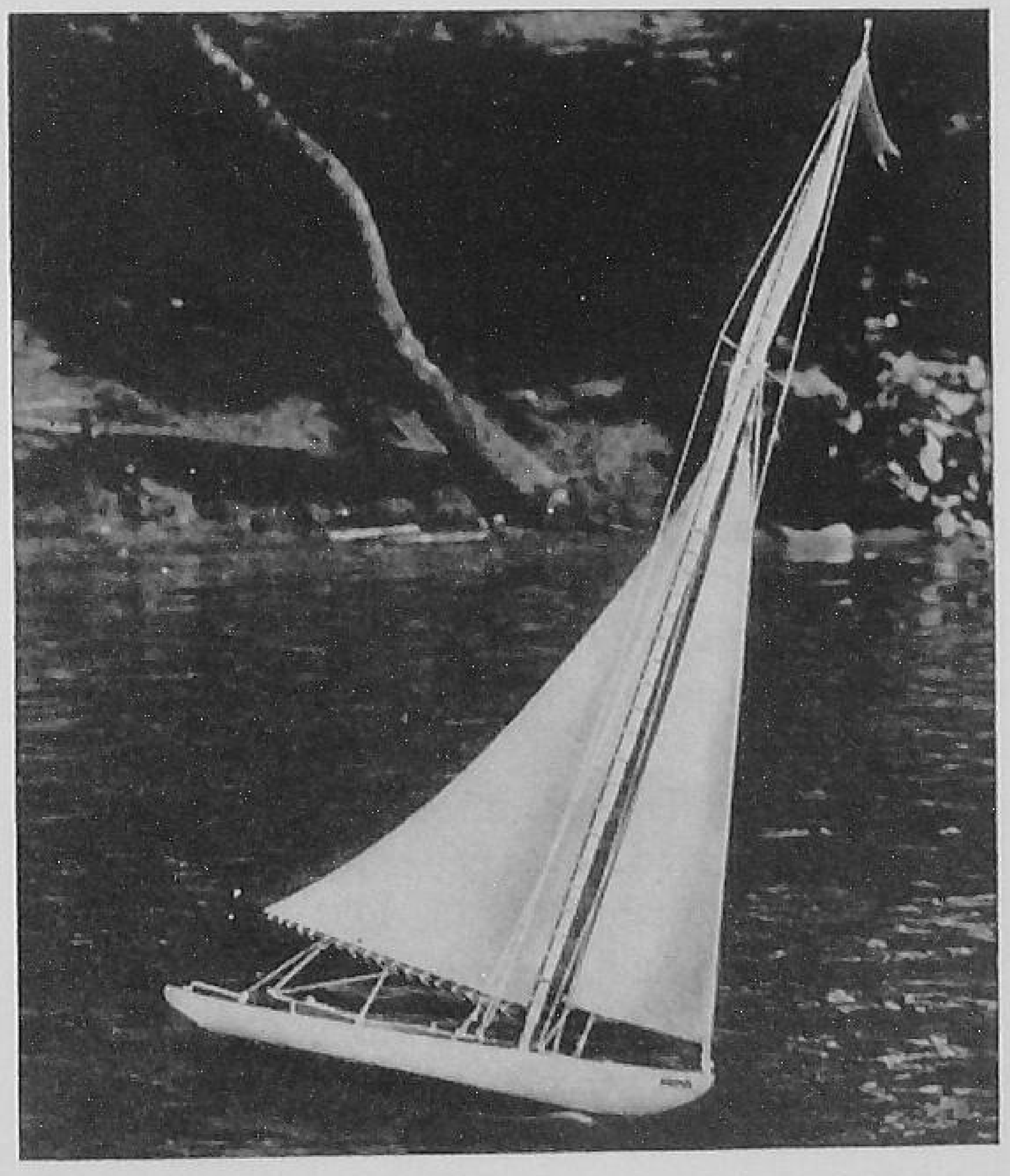
The chemistry involved in the preparation and manufacture of these new



Carved and polished novelty horse. Refer to processes for instructions. (*Courtesy Rohm & Haas Company*).

products is very complex and no attempt will be made to cover this phase completely. Ordinarily when a plastic material is produced it is compounded in such a manner that it either can be formed or molded by pressure and heat or can be poured for castings. Subsequently, the molding materials under the continued action of pressure and heat harden into a rigid or semirigid state. Most of the synthetic plastics are produced by a chemical process of linking together the molecules of which they are made.

This makes large heavy molecules out of the many smaller ones. Some of these formations include several hundred thousand molecules. It is this process, known as *polymerization,* that results in changing the liquid or pasty plastic materials into the solid form. The importance of this process will be emphasized later in our discussion of the way in which plastics are



Model racing yacht constructed almost entirely of Vinylite and Bakelite plastics. Strong and light and has excellent resistance to moisture, weal, abrasion, and impact. (*Courtesy Bakelite Corporation*).

made. More information on the chemistry of plastic materials may be found in Chapter XI.

Some of the advantages and disadvantages of modern plastic materials deserve mention. Probably one of the greatest attractions about plastics is their color adaptability. Almost an infinite variety of striking color effects is possible. Solid colors, series of colored sheets laminated together, marbleized effects, as well as varying degrees of transparency and translucency,

are all available. In finished form they are, in general, noted for their depth of color, richness, natural beauty, and permanency of surface gloss. Their light weight is a distinct asset and they do not rust, corrode, rot, or mildew. Of course, like all other materials they have their disadvantages. Some plastics are brittle, or soft, or weak. In general, however, they owe their popularity to the fact that they have replaced materials whose qualities were inferior. None of them are perfect, but the research chemists are fast approaching the point where they can make plastic materials with characteristics suitable to replace some of the conventional fabricating or building materials.

Brief History of Plastics

Considering the great strides that have been made in creating these marvelous new products it is difficult to realize that the development of plastic materials dates back only about ninety years—to 1855. At that time an Englishman named Alexander Parkes treated cotton with nitric acid (in the presence of sulfuric acid) and obtained the important product "pyroxylin" (nitrocellulose). Some years later, in 1868, John Wesley Hyatt added camphor to pyroxylin and created the first modern plastic "celluloid."

Strangely enough, it was the game of billiards that inspired the creation of celluloid. An offer appeared in the paper for a prize of $10,000 for the discovery of a satisfactory substitute for billiard ball ivory. This offer attracted Hyatt's attention and, more or less by accident, he made his phenomenal discovery. While applying a mixture of pyroxylin and ether, called collodion, to a cut finger, it occurred to him that this substance might be the foundation for the required material. Subsequent experimentation with a mixture of camphor and pyroxylin under the influence of heat and pressure produced a strong, durable, new plastic material which was given the trade name celluloid. A number of articles such as collars, cuffs, shirt fronts, headbands, bracelets, and toilet articles were manufactured in quantities from this product.

A large group of new and better materials known as "cellulose nitrate plastics" have been derived from the basic material pyroxylin. The original safety glass was made from cellulose nitrate. Here again an important discovery was made more or less by accident. A French chemist, Dr. Edouard Benedictus, found that the broken pieces of a bottle that had contained collodion were held together tightly by the dried film. He later witnessed an accident in which a young woman was severely cut by broken

glass. Subsequently he applied himself to the task of making safety glass and was successful. The first patent rights, however, were granted to John Reed, an Englishman, who also had invented a process of cementing layers of glass together with a plastic material much like pyroxylin.

The next significant step forward was made in 1909 when Dr. Leo H. Baekeland, a Belgian chemist, developed a new resinous plastic from carbolic acid and formaldehyde. Many before him had struggled with the problem of obtaining a satisfactory substance from the carbolic acid-formaldehyde combination. As far back as 1872 Professor Bayer had discovered that the union of these two chemicals resulted in a strong, hard, resinous material, but the results of the reaction were so unpredictable that no commercial importance was indicated. For nearly two decades the subject was dormant and then, about 1891, Kleeberg undertook to revive it. Many others, such as Blumer, Smith, Luft, Fayolle, and Story, attacked the problem, trying the effect of various chemicals and of various methods. Each failed in some important respect and no practical plastic product evolved. So many widely different results could be obtained, using the same ingredients under seemingly identical conditions, that the problem seemed incapable of solution.

Dr. Baekeland, after having solved several important chemical research problems and having become a professor of chemistry at the early age of twenty-four, decided to tackle this tantalizing puzzle of the phenol resins. He built himself a little laboratory adjoining his home in Yonkers, N. Y., equipped and stocked it, and began what proved to be a four-year battle of chemical skill and perseverance against a seemingly insurmountable problem.

In describing this work Mumford[1] states: "In all previous manifestations of this phenol formaldehyde combination, there had been revealed an almost human perversity, a mischievousness that bordered on diabolism. It always did the unexpected, and did it provokingly well." "In fact," said Dr. C. F. Chandler, in presenting the Sir William Perkin Medal to Dr. Baekeland in 1916, "when formaldehyde is let to react to phenol under ordinary circumstances almost anything may happen but the formation of Bakelite."

After many trials and tribulations and a long period of systematic research, at last Dr. Baekeland found the solution. The right amounts of the correct chemicals plus an adequate amount of heat and pressure for

[1] John K. Mumford, *The Story of Bakelite*, New York: Robert L. Stillson Company, 1924.

the required time. The liquid changed under these conditions to a beautiful transparent piece of amber, molded to the exact shape of the receptacle. It differed from amber, however, in that it was much harder and more heat resistant. It not only would withstand the action of many solvents, acids, and alkalies but was stronger than the amber that it resembled. Its heat resisting properties combined with its usefulness as an electrical insulator soon created a demand that has steadily grown to this day. Its usefulness was at first somewhat limited by its brittleness, but in combination with powdered wood flour its toughness and molding characteristics were greatly improved. Asbestos powder is also used as a filler where extreme heat resistance is essential.

The materials from which this new substance was created are readily available. Phenol is obtainable from the distillation of coal tar and may be also synthesized by various methods. Formaldehyde, also known by the commercial name of Formalin, may be easily produced by the oxidation of alcohol. The production of this product grew by leaps and bounds as the demand increased. New uses were found and new methods of manufacture developed. The original Bakelite resin has been combined in many ways with mixtures of flour, mica, asbestos, and graphite, according to the need. It also has been used to bond together cloth and paper by impregnation. These so-called "laminated" products have been the basis for extensive commercial uses, where strength, toughness, and electrical resistance are needed.

Bakelite has played a truly important part in wartime. There has been scarcely a single phase of military operations in which this substance has not been of importance. Gears, ignition parts, insulation of wires, tube bases, knobs, dials, propellers, and a host of other applications were essential to the great industrial armament production. It may be said that the creation of Bakelite, coming as it did when the need was great, provided the basis for the present-day, ever-growing plastic industry. Applications in everyday living have become just as important as wartime needs.

In 1890 a new and important plastic was discovered. Treating the substance "casein" (contained in common milk) with formaldehyde produced a durable substance resembling ivory. This material was ideal for such articles as buttons, buckles, and ornaments. Casein plastics have not been as popular in the United States as elsewhere, possibly because the surplus milk supply here is used for a great variety of other products.

The commercial possibilities of plastic materials were quickly recognized and progress has been phenomenal. New and better plastic materials were

rapidly developed to meet the needs of multitudinous new uses. There are roughly thirty basic plastics known today, about half of which have been created since 1925. Several of these were developed after the beginning of World War II and are so new that they are not yet widely used. One of these, called Allyl, appeared in 1942 and is said to rival glass in its proper-

Typical table mats made from rigid Vinylite sheet. The designs are painted on the underside. A protective bottom colored section is cemented or heat sealed around the edges. (*Courtesy Bakelite Corporation*).

ties. Another, also introduced in 1942 and called Polyethylene, is lighter than any other plastic and also tough and flexible. In 1943 the Silicones were introduced. This group includes a varnish that has desirable insulating properties, a lubricant that is resistant to heat and cold, and a rubber whose properties are unchanged through a wide range of temperatures. Practically every branch of industry is being effected more and more by the extremely useful application of these new materials.

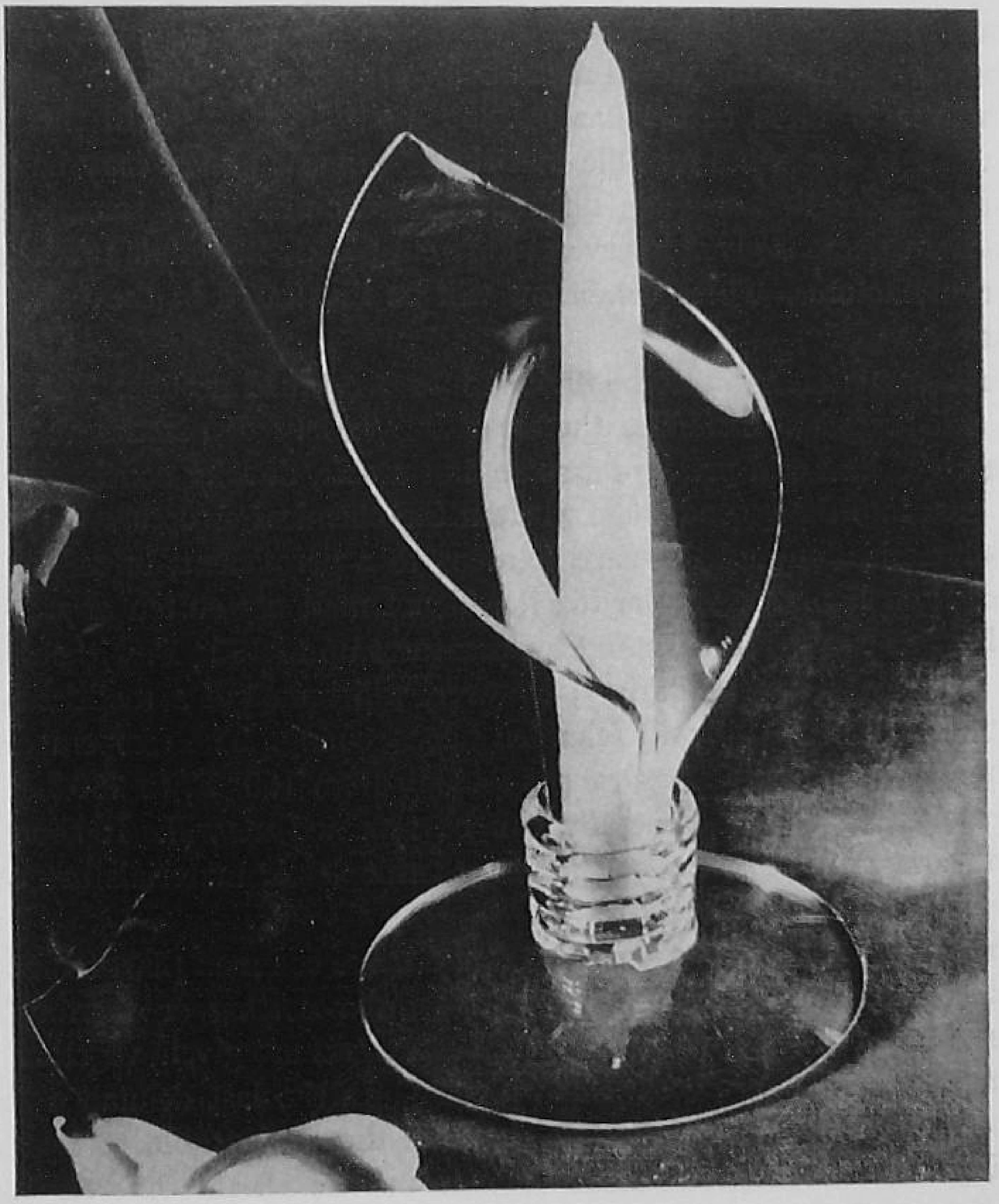
The order in which some of the more important plastic resins have appeared is shown below:

1855—Pyroxylin
1868—Celluoid
1890—Casein resin
1909—Bakelite
1919—Casein plastic introduced commercially in America
1926—Alkyd
1927—Cellulose acetate (Lumarith)
1930—Styrene
Urea-formaldehyde
Vinyl
1931—Acrylic
1932—Cellulose acetate butyrate
1936—Methyl methacylate (Lucite and Plexiglas)
1937—Ethyl cellulose
Lignin
Polystyrene
Vinyl butyral
1939—Melamine formaldehyde
Ethylcellulose
Vinylidene chloride
1942—Allyl
Polyethylene
1943—Silicones
1944—High heat-resistant plastics such as:
Styrene
Copolymers

How Plastics are Classified

It is obviously impractical here to discuss the methods of manufacture, the characteristics, and uses of the imposing array of plastic materials now available. Such a treatise would run into many volumes of more or less technical information not particularly useful to the craftsman. It is possible, however, to simplify somewhat the over-all picture by classifying the plastics into four general groups according to the chemical source—namely, natural resins, synthetic resins, cellulose resins, and protein resins.

The natural resins have already been mentioned in Chapter I. The synthetic group include a great variety of resins compounded or built up chemically from such chemicals as phenol, formaldehyde, urea, acetylene,



Plexiglas (thermoplastic) lily candle holder. Because thermoplastics can be softened by heating they can be easily formed into a variety of useful articles. (*Courtesy Rohm & Haas Company*).

petroleum, glycerol, and phthalic anhydride. The cellulose plastics have their origin in wood cellulose or cotton linters compounded with various other chemicals such as nitric acid, acetic acid, sulfuric acid, butyric acid, camphor, caustic soda, etc. They are a very important group and hold an

imposing position in the plastic industry. The protein group includes plastics made from materials like milk, soybeans, coffee beans, peanuts, and other agricultural products.

The numerous members of the four groups have been given descriptive chemical names and also are labeled with distinctive trade names according to the choice of the individual manufacturer.

The use of these names has become a little confusing to the novice because it is sometimes possible that the same basic plastic may be manufactured under two or more different trade names. Also sometimes the same trade name is given to several different plastic materials produced by one manufacturer. These conditions will be illustrated in the tables that follow.

These materials can also be divided into two broad groups: *Thermosetting* and *thermoplastic*. The thermosetting variety of plastics under the influence of heat and pressure assume first a soft, doughy consistency and then pass into the second stage wherein the chemical structure is changed by polymerization and the mass hardens to a permanent, infusible state If this type of plastic is reheated it will not melt nor soften appreciably, and in some cases will withstand temperatures up to 400° F. without charring. The thermoplastic variety, however, will remelt if a moderate temperature is reached and will reharden upon cooling. The temperature for resoftening of thermoplastics ranges roughly from 160° F. to 280 ° F. and the resoftening process generally can be repeated at will. It should be noted, however, that some of the new thermoplastic materials are of the high temperature resisting type.

The tables that follow show some of the more common plastic materials classified according to whether they are thermosetting or thermoplastic types of material. The generic or chemical names are given, together with common trade names associated with them. In the last column a few of the outstanding characteristics which make them adaptable to craftwork are listed. No attempt has been made to include all the different plastic materials or all the trade names. It is practically impossible to much more than scratch the surface in listing the possible craft uses but the table provides information that is fairly representative of conditions at the present time.

Thermosetting Plastics

Chemical Name	*Common Trade Names*	*Adaptability to Craftwork*
Cast Phenolics	Bakelite Catalin Gemstone Marblette Opalon Prystal	Outstanding craft material Easy to work Many colors, forms, and shapes Transparent, translucent High luster Will soften in hot water
Phenolic Molding Resins	Bakelite Durez Durite Indur Makalot	Very little (for molding material) Press and dies necessary
Phenolic Casting Resins	Catalin Durez Marblette Resinox	Used in slush or solid molding to obtain either translucent or almost transparent castings
Urea Formaldehyde	Bakelite Beetle Plaskon Sylplast	Very little (for molding only)
Melamine Formaldehyde	Melmac Plaskon Resimene	Not available
Allyl Alcohol	Allymer Kriston M. R. Resins	Not available (experimental)
Laminated Plastics	Formica Insurok Lamicoid Micarta Phenolite	Excellent materials for shelves and table tops Highly resistant to heat, acids, alkalies Hard and durable Many attractive colors

Thermoplastic Materials

Chemical Name	*Common Trade Names*	*Adaptability to Craftwork*
Acrylics (Methyl Methacrylate)	Crystalite Lucite Plexiglass	Wide applications Many forms and shapes Easily worked Many colors High polish Easily shaped or twisted Crystal clear Good optical properties
Casein	Ameroid Galorn	Fairly common Sometimes used for buttons, buckles, and novelties Will take a brilliant polish
Cellulose Acetate	Bakelite Chemaco Fibestes Kodapak Lumarith C. A. Nixonite Plastacete Tenite I Vuepak	Very good material—available in thin, flexible sheets and rods and tubes Tough and flexible Easy to dye and may be painted or lacquered Used for packaging
Cellulose Acetate—Butyrate	Tenite II Hercose	Available generally as tubes, and extrusions Easy to work Easy to cement Very light, used for wall board trim, table edging, etc.
Cellulose Nitrate	Amerith Celluloid Monsanto C. N. Nitron Nixonoid Pyralin	Used as celluloid sheets which are familiar to all Also available as rods and thick sheets

Chemical Name	*Common Trade Names*	*Adaptability to Craftwork*
Ethyl Cellulose	Ethocel Ethofoil Lumarith Lumarith E. C. Nixon E. C.	Good material Easy to work Available in thin or thick sheets, rods and strips Good color Easily cemented
Polystryene	Bakelite Cerex Loglin Lustron Polyflex Styraloy Styramic Styron	Used as insulating material by amateur radio enthusiasts Easy to work and makes very clear lenses Resistant to chemicals Can be made phosphorescent
Polyamides	Nylon	Used for making brushes, tassels, and knotted cords; also for stringing tennis rackets, nets, etc.
Polyethylene	Polythene	Not available
Shellac	Shellac sticks	None as a plastic
Vinyl Acetate	Gelva Geon Vinylite A.	Used as films or sheeting and is heat sealing Used for knapsacks, bags, aprons, belts, bowl covers, etc. Odorless, tasteless, and nontoxic
Vinyl Butyral	Butacite Butvar Geon Koroseal Saflex Vinylitex	Same uses as vinyl acetate

Chemical Name	*Common Trade Names*	*Adaptability to Craftwork*
Vinyl Chloride	Geon Saran	Used as packaging film, and plastic tubing which can replace brass or copper tubing Very resistant to acids, oils, or alcohols Resistant to corrosion Very strong Used in plastic screening
Vinyl Chloride-Acetate	Geon Vinylite V. Lumarith V. N. Transflex	Used as a window material to transmit ultraviolet rays Good for heat insulation
Vinylidene Chlorides	P. V. A.	None as yet

For suggestions on selecting plastic material for craft projects, see Chapters II and III.

Chapter II

PLASTICS USED IN CRAFT WORK

Of all the plastic materials that are manufactured, only a comparatively few have, until late years, been available. Until shortly before the beginning of World War II, the family of plastics that enjoyed greatest popularity was the cast phenolic group. For the past few years, however, the field of available plastic materials has greatly widened. New, exciting types of plastics have been put within the reach of the craftsman and promise a more extensive range of fabricated articles within the realm of his more or less limited activities.

It is proposed to discuss here only a few of the many plastics that could be used in craft work. Many of the plastics used in industry have properties nearly identical with those being used for craft work. These have been created for certain special uses in industry, often at a much higher cost. The discussion here will be limited to those properties and special techniques that seem to need emphasis to allow intelligent fabrication by the amateur craftsman. The actual fabrication processes that are more or less common to all plastic work will be discussed in Chapters V to X. Considering the kinds of projects made in the ordinary craft shop, stocking many different types of plastic materials is neither necessary nor desirable. It is very disconcerting to finish the parts of a project only to find upon assembling them that they cannot be cemented together because two or more different chemical groups of plastic materials have been used inadvertently. It is, of course, desirable to keep different chemical groups of plastics carefully separated.

The foregoing statements should not be interpreted to mean that the craftsman must limit himself to one or two chemical groups of material. Appearing on the market constantly are plastics that invite uses never before explored. Information about these new products is usually quickly spread not only by plastic manufacturers but by monthly homecraft magazines and craft supply houses.

There are a few fundamental ideas, concerning plastic materials in general, that should be considered before individual types are discussed.

It is a popular conception that plastics are soon to take the place of practically all metals and many woods used in the construction of machines and buildings. This idea is certainly not based on reliable evidence. All available information seems to lead to the belief that the plastic constructional materials will be used wherever practical to enhance and complement the conventional materials. For many applications plastics would not be at all feasible. Most plastics cannot be used when continuous heat above 400° F.

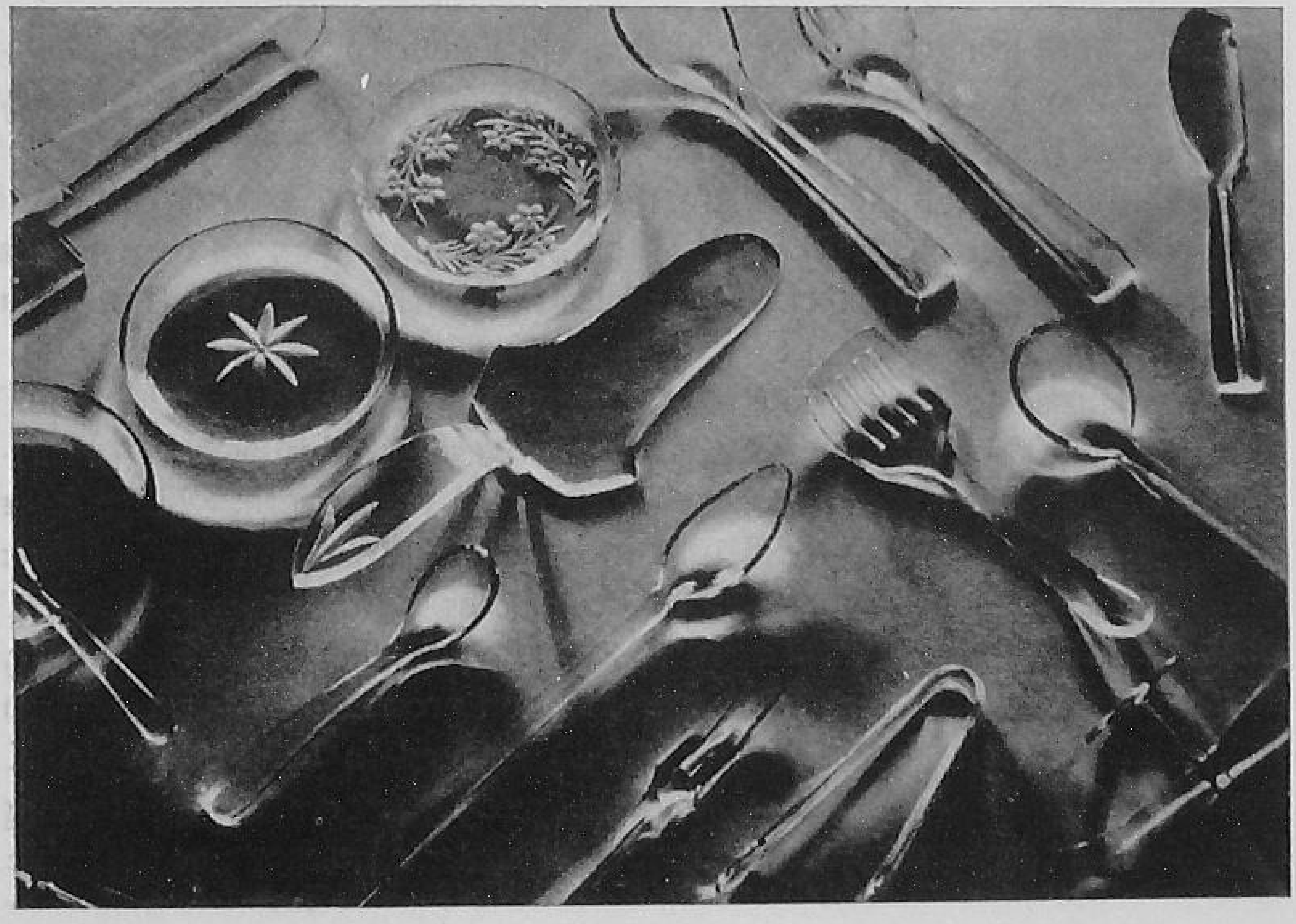


FIG. 1A. Plexiglas tableware. Easy to make, light, and easy to clean. Refer to page 827 for fabrication instructions. (*Courtesy Rohm & Haas Company*).

is necessary. Also most metals are far superior in surface hardness and toughness. Small machine parts that require high strength in a small space cannot yet be made successfully of plastics. However, for certain applications, wood and metal will almost certainly be replaced by plastic materials. Such qualities as chemical inertness, flexibility, transparency, "touchability," color range, electrical resistance, and surface permanence cannot be ignored in the industrial world for long. Many of the plastic laminates are competing with sheet metals in applications where strength and lightness are demanded. One of the outstanding qualities of some plastics is

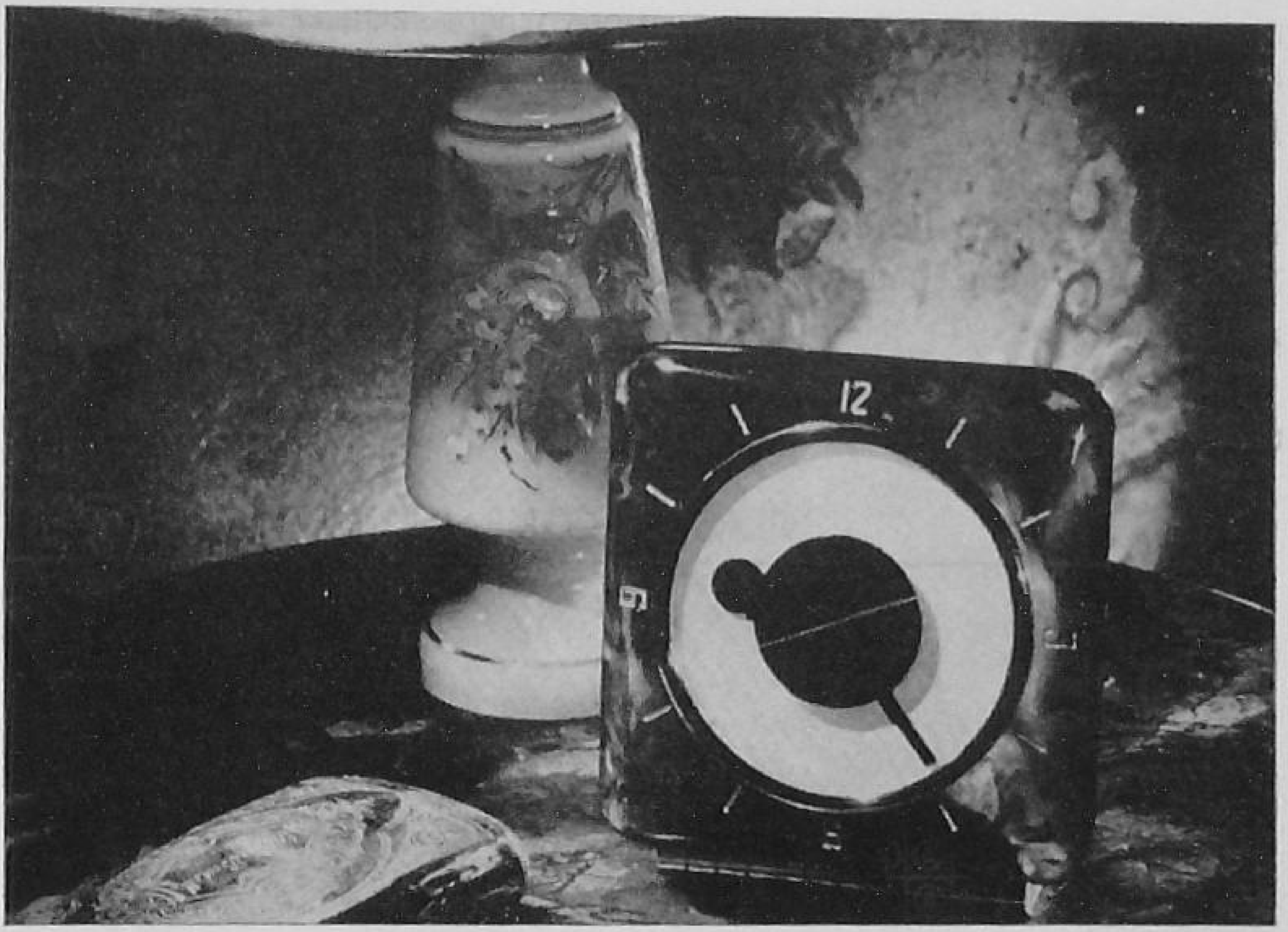


FIG. 1B. Clock stand of catalin plastic. Simple to construct, unlimited color choice, and rich brilliant surface. (*Courtesy Catalin Corporation*).

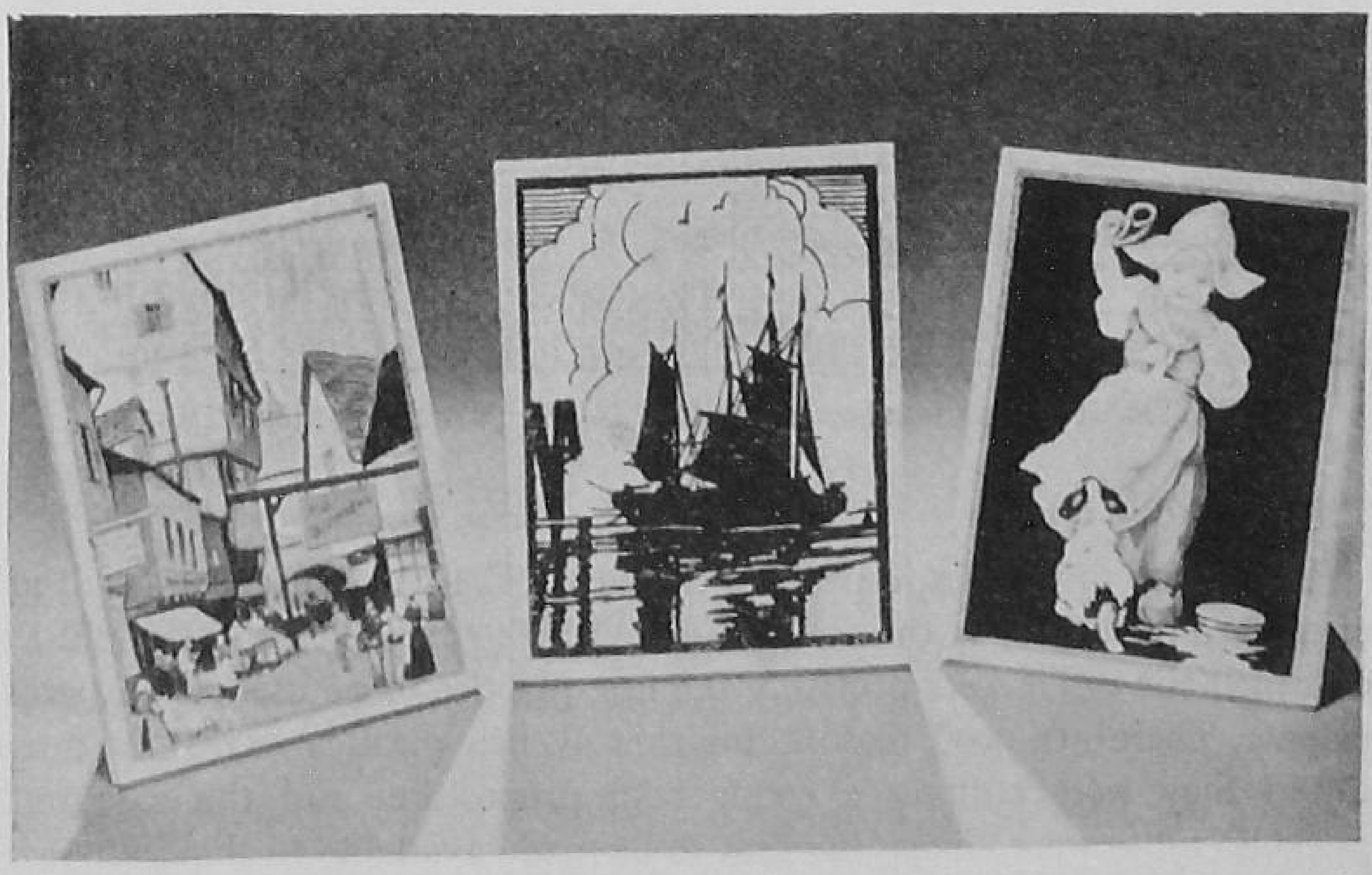


FIG. 2. Plaques of painted or burnt wood and other decorative surfaces may be permanently protected by a coating of Vinylite (Vinyl Chloride Acetate) plastic film. (*Courtesy Bakelite Corporation*).

high abrasion resistance. In applications where surfaces slide on one another, such as gears, chutes, etc., plastic materials outwear steel and are less noisy.

In view of the above considerations we must conclude that the plastics have a definte place in the advancing industrial world but that, as yet, they have not become blanket substitutes for conventional constructional materials.

The following chart compiled by the Bakelite Corporation provides valuable comparisons of the characteristics of various common plastics.

PLASTICS COMPARATOR

PLASTIC MATERIAL	TOUGHNESS (IMPACT STRENGTH)	FLEXURAL STRENGTH	TENSILE STRENGTH	COLOR	COLOR FLOW	WATER RESISTANCE	ACID RESISTANCE	CAUSTIC RESISTANCE	SOLVENT RESISTANCE	DIMENSIONAL CHANGE ON AGING	HEAT RESISTANCE	FLAMMABILITY	HEAT INSULATION	SPECIFIC GRAVITY	HARDNESS	LOSS FACTOR	RESISTIVITY	DIELECTRIC STRENGTH	MOLDABILITY AROUND INSERTS
PHENOLIC: GENERAL PURPOSE	10	3	3	7	1	6	3	4	1	4	2	3	2	8	5	10	7	4	1
PHENOLIC: LOW-LOSS	8	3	7	7	1	3	4	4	1	2	3	1	7	12	3	4	3	3	1
PHENOLIC: HEAT-RESISTANT	10	4	8	7	1	3	4	4	1	1	1	1	7	13	2		8	8	1
PHENOLIC: ACID AND ALKALI-RESISTANT	11	6	8	7	1	4	2	3	1	5	3	2	2	5	4			7	2
PHENOLIC: SHOCK-RESISTANT	2	1	5	7	1	7	4	5	1	6	3	4	3	10	5		9	8	1
PHENOLIC: TRANSPARENT	7	1	3	7	1	4	2	3	1	5	3	2	2	6	4	7	5	6	2
UREA	9	1	1	1	2	9	4	4	1	7	7	5	5	11	1	9	4	1	3
POLYSTYRENE	7	4	7	5	4	1	1	1	3	3	6	6	1	1	6	1	1	2	5
CELLULOSE-ACETATE	4	6	9	4	8	11	4	6	3	9	5	6	4	7	9	8	6	5	4
ACETATE-BUTYRATE	1	5	10	4	6	8	4	4	3	8	4	6	6	4	8	3			4
ETHYL-CELLULOSE	3	2	6	3	7	10	4	2	3	8	5	6	4	2	8	2	2	1	4
METHYL-METHACRYLATE	6	1	4	2	5	5	2	2	3	8	9	6	2	3	7	5		2	5
VINYL (NO FILLER)	5	1	2	6	3	2	1	2	2	3	8	6	2	9	7	6	3	1	4

NOTE—The low number is the best in the particular classification.

The Phenolic Group

This group of plastics, especially the cast resins, have been and still are of major importance in the craft field. With the exception of celluloid the cast phenolic resins were probably the first plastics to be used to any great extent. There are good reasons for this. When plastics were first introduced they were entirely a commercial proposition and the cast resin phenolic types were among the first to be made available to the craftsman.

These plastic compounds are based on the phenol-formaldehyde reactions. They are made as sirupy liquids of about the consistency of honey.

The ingredients—phenol, formaldehyde, plasticizers, lubricants, and dye—are heated for about 24 hours at an accurately controlled temperature and then are poured directly into lead or steel molds. These cast materials are odorless, tasteless, noninflammable, and may be polished to a wonderful surface luster. They are practically unaffected by water, oils, organic acids, and alcohol. They can be heated and shrunk on to metal and machined to close tolerances. They can be carved, stamped, engraved, or embossed. They are almost an ideal material from the craftsman's point of view because they can be easily sawed, drilled, tapped, carved, or otherwise machined. When using power equipment, care must be taken to avoid burning, which results in discoloration. Woodworking auger bits should not be used because they will cause cracking. These plastics belong to the thermoplastic type; yet, they will soften enough in hot water to allow some degree of forming. The usual procedure is to heat in very hot water (at the boiling point) approximately 3 minutes for each one-eight inch of thickness. Care must be taken to have the material thoroughly and uniformly heated so that it can be bent without cracking. For more intricate bends, a somewhat higher temperature up to 250° F. can be used. Cool in air or under cold water. This material may be softened somewhat by reheating twice or possibly three times but then will harden permanently so that subsequent bending will cause cracking. Metal findings of various kinds can be inserted into the soft plastic while it is hot. When cooling takes place, the plastic material contracts. The inserts will then be held tightly and permanently in the plastic. Not only are these materials tough, light in weight, and noninflammable, but they are also resistant to most oils, to moisture, and to chemicals. They are available in practically all colors and color combinations and are produced in all standard sizes of sheets, rods, cylinders, and tubes as well as many special shapes. As a basic material for the average craft shop, these plastics are recommended highly. It will be seen from the table on page 725 that plastic materials of the cast phenolic type have been given the trade names which include *Bakelite, Catalin, Gemstone, Marblette, Opalon,* and *Prystal.* The sources from which these materials may be obtained are given in Chapter III.

Within the last few years new materials in the phenolic group have been made available to the craftsman which allow him to form articles by the process of casting. The plastic material comes as a sirupy liquid which will remain for some time in the liquid state unless it is hardened by the action of a second liquid. The second liquid acts as an "accelerator" taking the place of the usual "pressure and heat" hardening method. A typical mate-

rial for casting and also cementing is called "Catalin Catabond #200 C.S." A hydrochloric acid accelerator is used (3 parts concentrated hydrochloric acid to 1 part distilled water). The accelerator is ordinarily mixed in the proportion of 10 parts liquid resin to 1 part acid accelerator. Larger proportions of acid will cause quicker hardening.

The casting method has proved successful in mounting and preserving certain scientific specimens. The object may be partially or wholly submerged in the casting liquid and when hardening takes place a permanent bond is established. Of course, where the object is totally submerged, a type of casting liquid which hardens to a clear or slightly bluish tinge is desirable, such as "Catalin #700 Resin" with a special accelerator. In general, in all casting a suitable mold must be obtained, or made, which will provide the required final form of the cast object. Because the "accelerator" liquids are ordinarily acids, the mold is often made of rubber latex that has been sprayed or "painted" over the form to be duplicated. The casting materials may be obtained from the Catalin Company or various retail supply houses listed on page 747. The process, known as "slush molding," is sometimes used to conserve material or to obtain a light hollow casting. In this process the casting liquid, mixed with the accelerator, is poured into a mold (usually rubber). Then the mold is tipped or otherwise moved so that the liquid congeals forming a thin plastic layer on the inside surface of the mold. Full directions for this type of activity are readily available from the several sources listed on page 751.

It is also possible to obtain small electrically heated presses of the compression type with special molds to fit the press. These may be used to form articles from certain of the molding materials in the phenolic and other groups. However, due to the high cost of fabricating the special molds that would be needed to satisfy the average craftsman's desire for originality, this type of activity is more or less limited to small toy making. The molding kits are available in toy departments of large retail stores and merit the serious consideration of the craftsman. Molding powders are available through the various craft supply houses.

Laminated Phenolic Base Compounds

The same type resin may be used for the laminated and the molded phenolic plastics. The molded type makes use of powders or shredded material impregnated with the resin. In the laminated type large sheets of canvas, paper, linen, silk, or other fibrous material are impregnated and dried. These sheets are then stacked in large hydraulic presses and pressed

under enormous pressure to definite thicknesses. These formed sheets may be fabricated in the flat form or, under proper conditions, may be molded to many shapes. This material has been used widely in industry for liquid containers, and more recently for table tops, counters, and walls. The surface may be decorated to simulate wood, metal, or stone and is practically impervious to the chemicals ordinarily contained in foods and beverages. The laminated type is also made into rods, tubes, and special shapes.

The Cellulose Group

This group is one of the largest and most important in the plastic field. This position of supremacy is merited by its great tensile strength and by the variety of forms and shapes in which it is supplied. The ease with which it can be fabricated into finished articles adds to its value for craft work. A wide range of colors is available.

1. *Cellulose Nitrate.* Cellulose nitrate (celluloid) is the earliest member of this family. It is available in the form of sheets, rods, tubes, films, and emulsions. It is tough, water resistant, transparent, and flexible. The one undesirable characteristic that somewhat limits its use is its high rate of combustion. This property makes it unsuitable for applications where it might be brought into contact with an open flame or high temperature. It fades badly with age. Cellulose nitrate is available under the trade names of *Amerith, Celluloid, Nitron, Nixoniod,* and *Pyralin.* This material has been practically superseded in the craft field by its noninflammable successor, "cellulose acetate," also commonly (but incorrectly) known as "celluloid."

2. *Cellulose acetates* are much less inflammable than the nitrates and are more resistant to fading. They are available as molding powders, in standard solid forms, and in a wide range of colors. When brought into contact with a flame this material will burn at a rate comparable to that of wood, fiber, cardboard, or other similar materials. It may be readily machined but has an abrasive which tends to dull the tools. High-speed steel or diamond tool bits are often necessary for production machining. Wherever possible a cutting action rather than an abrasive action (like filing) should be used.

In fabricating these materials the common processes may be used if certain precautions are taken. At low temperatures and in conditions of extreme dryness there is a tendency to chipping. To overcome this, be sure to store the material in a warm, and not too dry, place. In common with

many other plastics the improper use of power tools may cause local overheating and consequent discolorations. Cellulose acetates are thermoplastics which begin to soften at about 150° F. The correct temperature for hot forming ranges between 250° F. and 280° F. A simple oven which will attain these temperatures is described on page 785. If cellulose acetates are heated to much more than 280° F., small lines, called "Sheeter lines," are likely to appear during the forming process. For ordinary forming, like simple bends, the material may be heated in hot water at a temperature of from 160° F. to 212° F. depending upon the type of bend desired. Cellulose acetate softens in alcohol and in this condition may be greatly stretched or drawn. It is soluble in acetone, tetrachlorethane, or a mixture of ethylene dichloride and alcohol. Acetate chips or shavings dissolved in a small amount of acetone will serve as a suitable cement. Most manufacturers supply their own cement, usually called "acetate cement," which is generally preferable. The acetates are not suitable for use as water containers because of their relatively high water absorbing characteristics.

These materials may be dyed with hot solutions of aniline dyes, and several special inks have been produced that will adhere nicely. In the thin sheet form, cellulose acetates may be easily and conveniently cut with ordinary scissors. The material lends itself especially well to celluloid etching and wood cuts, which require the same techniques as are used in copper plate etchings, except that the former are much easier to do. Etchings may be copied on it because of its transparency. It is sold under the trade names of *Bakelite, Chemaco, Fibesto, Kodapak, Lumarith C. A., Nixonite, Plastacele, Tenite I,* and *Vuepak* (Fig. 3).

3. Cellulose acetate butyrate is similar to cellulose acetate and is handled in the same manner. It is very light in weight, strong, and resistant to weathering. Some familiar trade names for this material are *Hercose, Rexinite, Rextrude,* and *Tenite II.*

4. Ethyl cellulose is one of the newest of the cellulose group. This material is exceptionally strong and flexible especially at low temperatures. It has good electrical properties and is resistant to heat, acids, and alkalies. One form is manufactured under the name of Ethocel T. F. by Dow Chemical Company. Ethocel has a low melting point (about 375° F.) and may be readily cast. Because of its toughness it is being used in industry to make cast dies for forming sheet metal. It actually can be pounded on an anvil without breaking. Its use in the craft field is sure to be satisfying and extensive. It's solubility in many organic solvents makes it ideal for fabric coatings and lacquers. It retains its flexibility even at temperatures

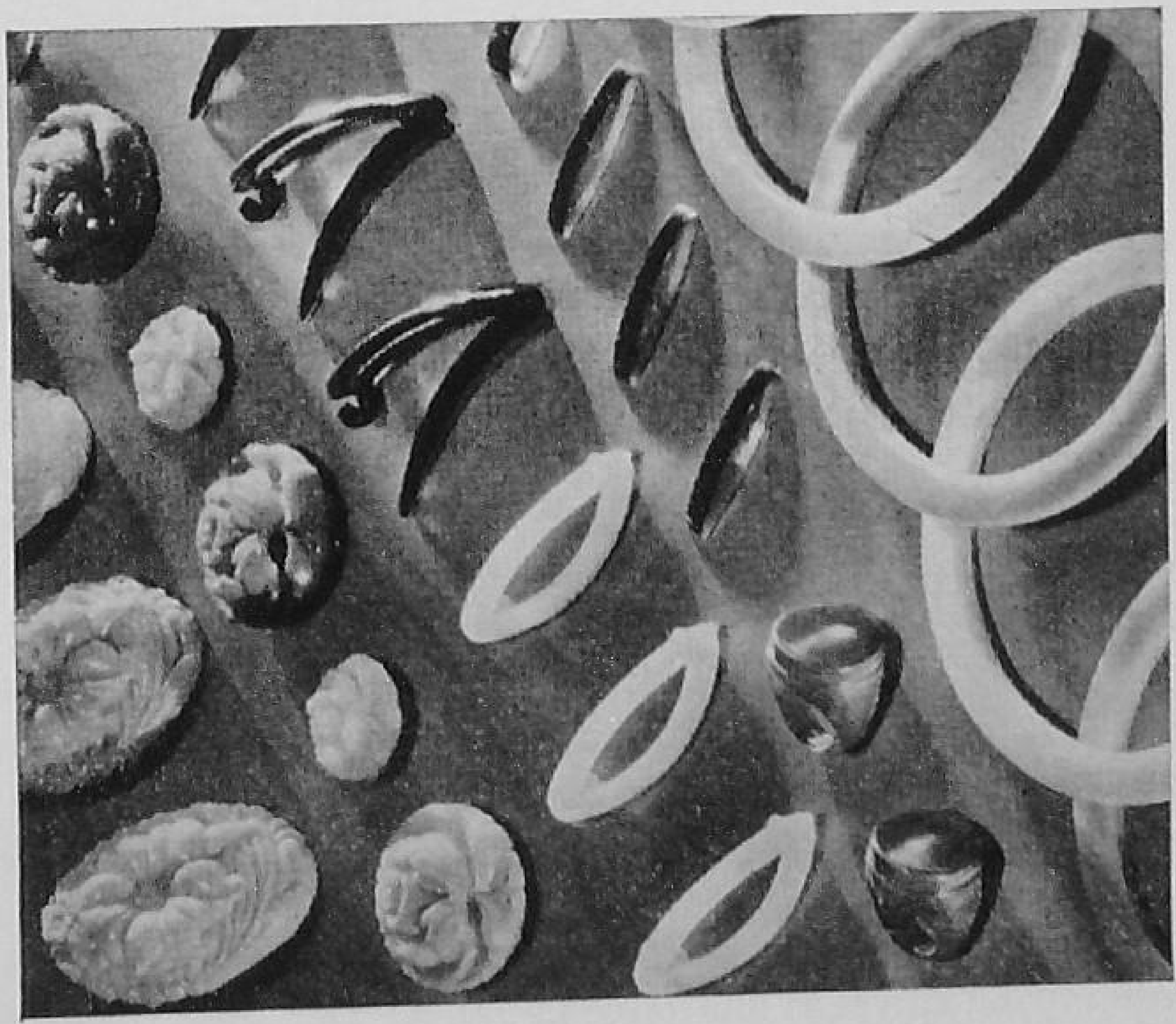


FIG. 3. Costume jewelry made from Tenite. (*Courtesy Tennessee Eastman Corp.*).

FIG. 4. Application of light-piping property of plexiglas in the medical field. Light from a flashlight is carried to the throat area through a carved Plexiglas rod. (*Courtesy Rohm & Haas Company*).

below zero and is very resistant to strong alkalies and dilute acids. In foil form it is widely used as a packaging material. It is fabricated like the other cellulose plastics. Trade names are *Ethocel, Ethofoil, Lumarith E. C.*, and *Nixon E. C.*

The Acrylic Group

Perhaps the most important member of this group is the synthetic compound "methyl methacrylate," known under the trade names of *Crystalite, Lucite*, and *Plexiglas* (Figs. 4 and 5). These materials are of the thermoplastic type and have characteristics that make them particularly well adapted to craft work. They are very light, being less than half as heavy as aluminum. They are about as hard as aluminum and copper and consequently must not be used where the surface is subject to scratching, such as on table tops, counters, and table ware. Plexiglas sheet is shipped with a protective coating of masking paper on both sides. This paper is never removed in craft work until all possible fabricating processes have been completed. The paper is easily removed by lifting an edge or corner and rolling up the paper as it comes off. The masking paper is also valuable in another respect—it serves as a means of laying out the size, shape, and hole centers for the part being made. After the lines are drawn with a pencil, a scriber or a razor blade may be used to score through the masking paper into the plastic surface. These guide lines should be visible, but not too deep, because thin sheet material will break along the scored line if subjected to much bending. In fact, thin sheet stock up to about 3/32" can be conveniently broken into smaller job-size pieces by this technique.

Plexiglas is strong but cannot be expected to stand up under the stresses that most metals will endure. It can be polished to a very brilliant, crystal-like surface. It is extremely clear, its transparency to light being about 92 per cent.

Advantage should be taken of this fact in designing projects for craft work. By designing the flat surfaces of the object so as to provide maximum reflection, many pleasing effects may be obtained. Angles of 45 degrees, which produce practically total reflection from the back inside surface of the part being made, are most effective. It is customary to decorate Plexiglas on the reverse side so that the decorations are viewed through the sheet. This causes the decorated portions to stand out in full brilliance.

Perhaps the most spectacular characteristic of Plexiglas is its ability to carry light rays around curves as illustrated in Fig. 4. This effect is caused

by the great transparency of the material. When the light enters, it is reflected from the inside surfaces of the rod and, rebounding from surface to surface, even around curves, it comes out at the other end of the rod with little loss. This characteristic may be used to advantage for so-called "edge" effects. If the bottom corners of a box are beveled at an angle of 45 degrees, the light enters at the top edges and is reflected in a sort of periscope fashion so as to emerge at the opposite top edges. This causes the top edges to glow as if they were producing light (Fig. 5). There are many other ways in which the great transparency of this material can be

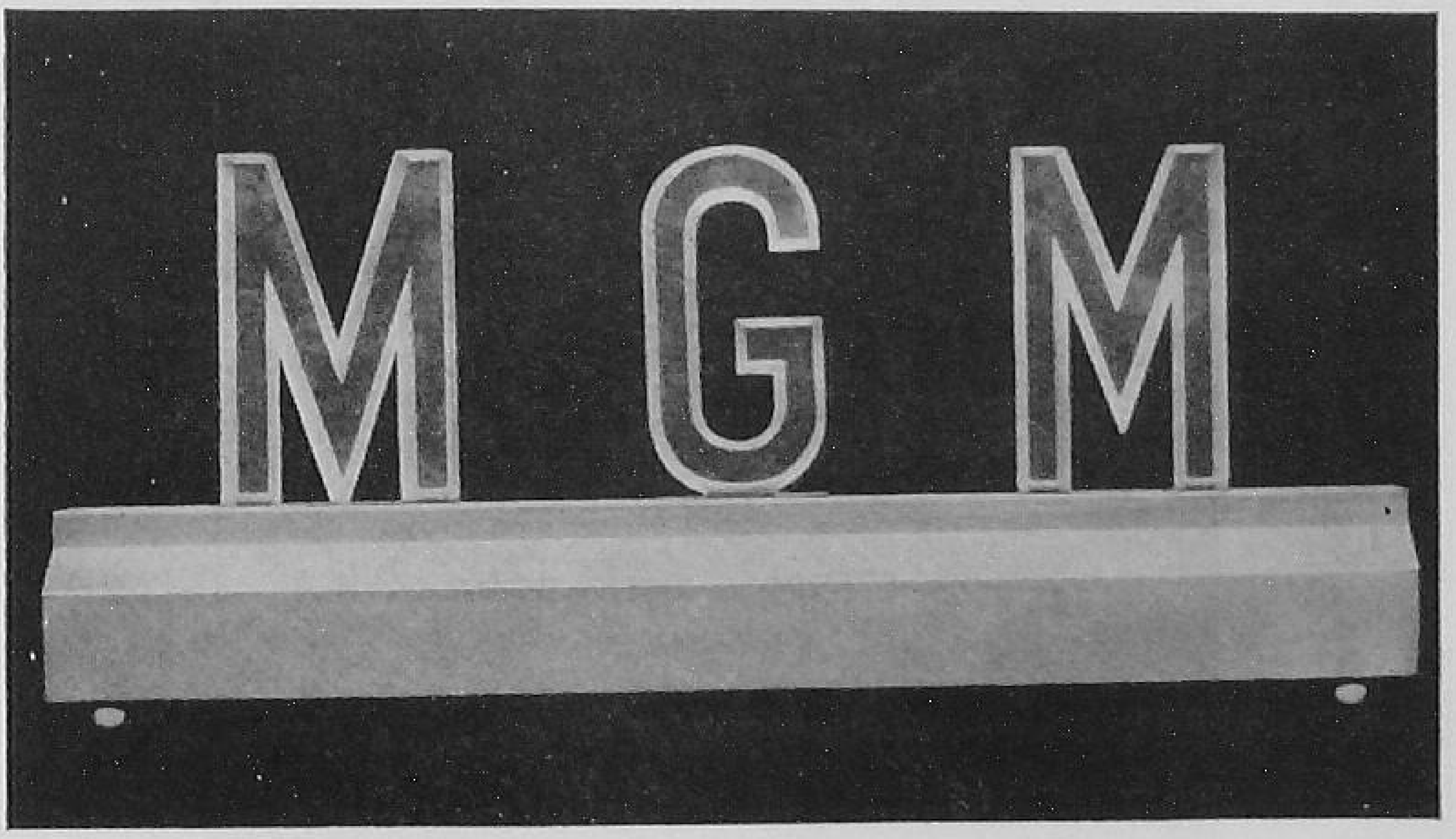


Fig. 5. Illuminated letter sign. Light-piping properties of plexiglas used to obtain brilliantly outlined letters. (*Courtesy Rohm & Haas Company*).

utilized. When the light enters the edge of a flat sheet it will stay in the interior of the sheet as long as the surfaces are polished. If the light reaches an unpolished region, some of it will leave through this region. Consequently, a light at the edge of a sheet of decorated Plexiglas illuminates the decorated portions brilliantly. One factor that limits the application of edge lighting is the heat from the light source. An ordinary incandescent lamp gets quite hot and so cannot be placed close to the edge of the Plexiglas sheet unless special ventilating facilities are provided. The fluorescent lamps are ideal for this type of work. The lamp should be totally enclosed so that the light is seen only as it comes from the Plexiglas sheet or the illuminated decoration.

Plexiglas is easy to saw and almost any kind of a saw will do. Observe the same precautions that you would in sawing metal and wood. If a power saw is used, a light, slow, easy feed is best. Too fast a feed will cause jagged edges and possible "burning." A special band saw having about 4 teeth per inch will give good results. For the table saw, a special hollow-

FIG. 6. "Lucite" vase showing the ease with which this material may be bent and cemented. (*Courtesy of E. I. Dupont de Nemours & Company*).

ground blade with no set works well. However, with judicious handling the common blades will serve nicely. Do not try to cut the material too fast.

When drilling Plexiglas the common twist drills may be used. The only precaution necessary is that the feed must be slow. If much pressure is used the ordinary drill will dig in and stall. An experienced mechanic would regrind the drills so that they have a scraping instead of a cutting action. This is accomplished by modifying the cutting edge of the drill

and some practice is necessary for a satisfactory job. The drill should not be pushed down through the entire hole at once. Cut a little and then withdraw the drill so that the accummulated shavings are removed before they can jam or bind the drill. Ordinarily a lubricant is not necessary for Plexiglas. Being a thermoplastic substance, Plexiglas is easily formed. The temperatures for forming range from 225° F. to about 300° F., depending upon the thickness of the material and the type of the bend. Water boils at 212° F.; therefore Plexiglas, unlike the cast phenolics, cannot be formed by immersing it in boiling water. An oven similar to the one described in Section III, page 785, will be adequate for small jobs. A hot plate, flat iron, or electric grill may be used as the source of heat but the temperature control for these devices is not sufficient to make their use entirely satisfactory. A gas or electric stove oven with good temperature control is an ideal heating chamber. The plastic pieces being heated should be laid on fluffy cotton or smooth glass or glass-like surfaces and handled with cotton gloves to avoid scratching. If the temperature required for forming is not too high, the piece may be put into the oven in the fold of a piece of cloth for easy handling. As soon as the plastic has been bent to the required form it is allowed to cool in air or it may be immersed in cold water. If the piece is reheated after bending, it will revert to its original flat shape. This allows a mistake in bending to be rectified without damage to the piece. This characteristic is known as the "memory effect."

There is another method of heating called "strip heating." In this case the plastic is heated by a long heating element along the bending line. A strip heater can be made from an electric iron or toaster heating element. The element should be mounted on a 3′ strip of asbestos board and provisions made to support the plastic piece above the hot element. The toaster or electric-iron element becomes red hot when connected across a 110 volt source. This temperature is usually too high for ordinary work. A 200-watt bulb or two 100-watt bulbs may be inserted in the circuit to limit the temperature of the element to the correct value. When the correct bending temperature is reached the plastic will be flexible enough to allow smooth, clean bends along the heated portion.

Many different types of forming operations are possible with Plexiglas. It can be bent, twisted, stretched, compressed, or blown to innummerable shapes. The possibilities are almost unlimited. All that is necessary is to attain the correct temperature, do the forming, and then allow the plastic to cool in its new shape. Jigs and clamps are helpful in most forming jobs because they hold the plastic exactly in the desired shape until it is cool.

Small objects can be embedded in the hot plastic merely by pressing them into it. The plastic material contracts when it cools and "freezes" the object securely in place. Small holes can be punched in cold Plexiglas with a hot needle or nail. The metal needle must be withdrawn before the wall of the hole cools; otherwise it will be held firmly in the hole. In much the same manner, small screws, hooks, or other fasteners can be inserted into the cold sheet by heating them and then pushing them into place.

One of the comparatively new techniques being used more and more for surface decorations is that of pressing a design into the hot plastic. The design can be drawn "free hand" with blunt stamping instruments, such as a scriber, or with saddlers stamps used for leather work. An embossed or engraved metal sheet can be forced into the hot surface to obtain a picture or other surface decoration. With a little practice metal objects, such as coins, rings, or other trinkets, can be embedded between two hot pieces of Plexiglas. The plastic pieces and the metallic object are heated in the oven to a rather high forming temperature (about 280°–290° F.). The metallic object is placed between the two pieces and then pressure is applied by means of a hand press or a vise. The two pieces of plastic will, if properly heated and pressed, join together in an invisible joint with the metallic object embedded permanently inside.

Plexiglas pieces are easily joined together by cementing. There are several important factors to take into consideration. The joint should be strong, clean, and practically invisible. Also an easily applied, quick acting cement is desirable. The glues and cements used for wood, leather, and various other fabrics are not satisfactory in meeting these requirements. They all are deficient in some important respect. Consequently, Plexiglas is joined by using a solvent which softens and dissolves the surface of the pieces to be joined and allows them to intermingle. When the solvent evaporates the joint is made up of actual Plexiglas derived from both pieces.

If a job requires extra strength or thickness, Plexiglas chips are sometimes dissolved in the solvent before it is applied. It is obvious that this type of cementing requires new and specialized techniques on the part of the craftsman. For one thing, more care in preparing the joint is necessary. The fit is all-important; otherwise a perfect joint will not result. To test the fit, the joint should be wet. If a film of water stays in the entire joint, the fit is satisfactory. When the plastic solvent is put into the joint in place of the water, the resulting joint will then be almost invisible. The cement is applied in various ways—sometimes with a brush, sometimes

with a hypodermic needle, and sometimes by dipping the pieces in the solvent. The type of joint determines the technique. In some cases it is desirable to protect the area around the joint with masking tape. Use just enough cement to completely fill the joint.

The solvents used as cements are organic compounds; ethylene dichloride (EDC), cement 1-c (1, 1, 2 trichlomethane), methylene dichloride (MDC), chloroform, acetic acid, and acetone are suitable. The first two of this group are probably the most desirable.

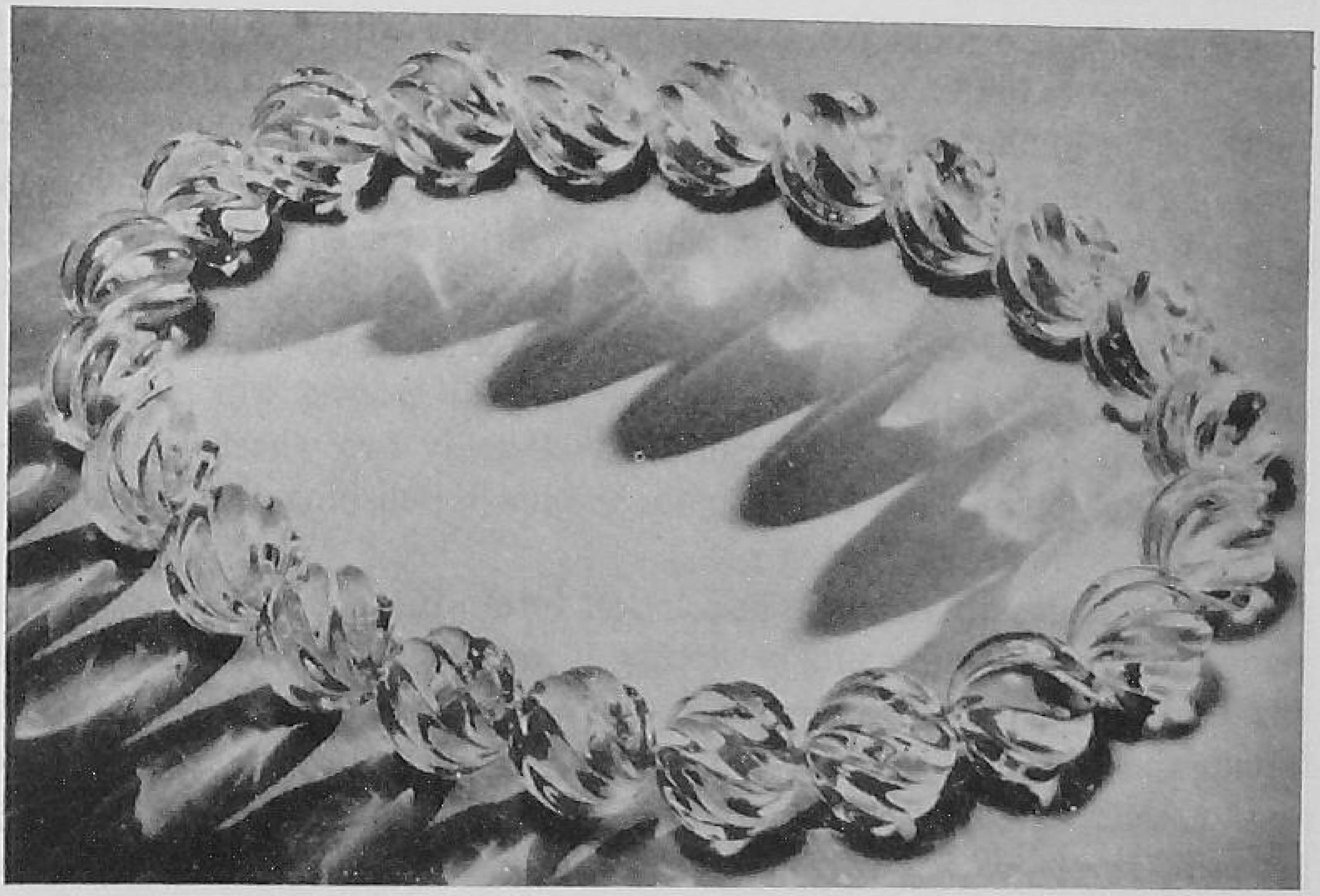


FIG. 7. Carved plexiglas necklace sparkles like crystal. Refer to process. (*Courtesy Rohm & Haas Company*).

After the cement is applied the pieces must be held stationary until the solvent evaporates (30 seconds to 3 minutes). The necessary jigs and fixtures should have been prepared in advance and tested for correct operation. In case a dry spot appears in the joint, more solvent is applied with a hypodermic needle, a brush, or a toothpick. Although the joint is solid after about 3 minutes, it should be allowed to set for 24 hours before being subjected to strain.

Plexiglas can also be joined by welding. The edges to be welded must be heated to a high temperature to obtain a strong joint (660° F.). Consequently this technique is used very little in craft shops. However a very

satisfactory joint can be made between parts not subjected to undue strain if the temperature is raised to about 300° F. and some pressure is used.

One other important characteristic of Plexiglas is its high electrical insulating qualities. This quality allows it to be used for many applications in the electrical industry. Small radio cabinets, testing prods, switches, etc., may be made by the amateur radio fan. However, do not use Plexiglas where the temperature exceeds 210° F.

The brilliantly polished surface necessary to bring out the maximum beauty in Plexiglas is quite easily attained. The pieces are sanded first with coarse sandpaper (about No. 250 grit) and finally with fine paper (about No. 600 grit) to obtain a very smooth surface. The next step is to buff and polish. The buffing is usually accomplished by using an abrasive on a revolving flannel or cloth wheel. The abrasive can be one of a great variety of commercial products now available. Whiting mixed in tallow works well. The plastic piece is held up to the wheel with sufficient pressure to obtain the necessary abrasive action. The piece must be kept in constant motion with respect to the wheel so that lines or grooves will not appear. Too much pressure will cause "burning." Usually two wheels are used—one for rough buffing and the other for the finish polishing. No abrasive is necessary on the final polishing wheel.

Plexiglas is usually obtained in colorless form. It can be dyed any one of many different colors by simply dipping it into a suitable dye. The dye is mixed in a solvent (usually acetone) and so dissolves a little of the plastic leaving the color in the surface film. The dye is made by dissolving analine dye in acetone (saturated solution) and then adding some water. Sixty per cent acetone to 40 per cent water is about right. The color is only on the surface and is easily buffed off. The intensity of the color is determined by the length of time the plastic is left in the dye. Usually about 1 to 2 minutes is sufficient. Freshly made dyes work best.

Paint can be used on Plexiglas, usually on the reverse side to bring out the brilliance obtained by viewing it through the piece. Oil paints and lacquers work well, and show-card colors may be used on unpolished surfaces. It is important to spread the paint evenly on the surface because all irregularities will be intensified by looking through from the front side.

Plexiglas may be carved easily. It is not cut as are wood and metal but, rather, it is scraped. The tools used must have keen scraping edges because at best the process is slow and laborious. Much quicker and far easier is the use of small hand-motor tools that drive small cutters and burrs. This type of ornamentation is described in detail in Process No. 18.

The Polystyrene Group

This material promises to become one of the most widely used plastics. It is available in the sheet and rod form. Because of its high insulating qualities it is particularly suited for the radio and electronic field. "Ham" radio enthusiasts will find it very useful for construction work in both the low- and high-frequency fields. However, it should not be used where it may be subjected to temperatures above 167° F., because at this temperature some of its favorable electrical characteristics disappear. It is soluble in gasoline, kerosene, and oils of a similar nature and, therefore, must not be allowed to come into contact with such solvents. In the machining processes, local heating should be prevented by slowing down the cutting rate and by the use of a proper coolant. Water will serve as a coolant but there are commercial coolants, like Shell Oil Company's "Vergo Oil 38P" and Socony Vacuum Oils "Solvac 100-M Special," which are more efficient. Power saws with coarse teeth (12–15 teeth per inch) and drills with small rake and good chip clearance should be used (see Fig. 64 in Process No. 29). In tapping and threading the fit should be quite loose. Polystrene strips can be welded by heating to 230° F. and pressing together. Bending is easiest at about 200°–220° F. Cementing is done with a cement made by dissolving Polystrene shavings in a suitable solvent. This plastic may be joined to many other materials, including metal, by using the *Thiokol, Glyptal,* and *Reanite* type cements. The specific directions come with the cement but the general directions for cementing all plastics may be used. Trade names are *Bakelite, Cerex, Loalin, Lustron, Polyflex, Styraloy, Styramic, Styron.*

The Vinyl Group

These materials are used primarily in the craft field in the form of surface coatings or as film. Many articles, such as lightweight tents, gun cases, shower curtains, aprons, bathing caps, ladies' handbags, shoes, and upholstering materials, are easily made from this plastic. Vinyl plastics are odorless, tasteless, and nontoxic. They will not support combustion and are little affected by alkalies, oxidizing agents, and most acids. This plastic may be obtained as rods, tubing, and noncracking black plastic patent sheets and film. It is widely used in the electrical field as thin tubing (spaghetti). Trade names are: *Gelva, Geon, Transflex,* and *Saran.*

The Polyamide Group

One of this group is known by the name Nylon. This plastic made possible a new fiber which supplements weaving materials. It is also used for various other items, such as brushes, window screens, combs, and tableware. It will be available to the craftsman in the form of thread, cloth, sheets, and rods. Many other uses will develop when the production of Nylon is increased.

The Laminates

These materials are characterized by great strength, beauty, durability, and workability. They can be fabricated much like wood or soft metal and, indeed, promise to replace wood in many applications. Decorative laminates are harder than marble and will wear exceedingly well. They are practically impervious to alcohol, fruit juices, and common solvents, and are greatly resistant to burning.

The foregoing discussion of some of the various plastics must not be construed as a complete treatise. Many of the new materials which are very important have not yet been made available to the craftsman.

Chapter III

SOURCES OF MATERIALS AND SUPPLIES

During World War II many new plastics were created and new facilities for the manufacture of both old and new materials were provided. This great concentrated effort has resulted in the release, to the school and home craftsman, of numerous plastic types never before available and has also brought the cost of these materials within reach of the average craftsman's resources. Many manufacturers who sold only in wholesale lots now are retailing their products and the number of retail concerns handling plastic materials and supplies is increasing rapidly to the point where the craftsman should have little difficulty in locating a convenient source.

The following list of companies carry plastic supplies and materials. Most of them also carry a fairly complete line of other craft tools and materials, many of which are applicable to the fabrication of plastic articles. It must be realized that specific and specialized equipment is not necessary in working with plastics. For instance, the sandpaper, polishing agents, tools, etc., sold by one company are, in general, as usable as the same grade articles handled by any other sources. This does not mean that one should not be very careful in his selections. Many inferior grades of tools and supplies are being offered to the public and, therefore, the craftsman should, in general, buy only from concerns known to be reliable.

It is not possible here to list specific articles or materials carried by individual supply houses. This type of information is in a state of constant change and it is recommended that the catalogues of several of the companies that are conveniently located be obtained and examined.

Advance Plastic Co.
3509 East 12th St.
Oakland 1, Calif.

American Handicraft Co., Inc.
915 Grand Ave.
Los Angeles, 15, Calif.

American Handicraft Co., Inc.
45–49 South Harrison St.
East Orange, N. J.

American Handicraft Co., Inc.
12 East 41st St.
New York, N. Y.

Berton Plastics, Inc.
19–27 West 21st St.
New York 10, N. Y.

Brodhead-Carret Co.
4560 East 75th St.
Cleveland 5, Ohio

Carmen-Bronson Co.
165 East 3rd St.
Mount Vernon, N. Y.

Craft Service
360 University Ave.
Rochester, N. Y.

Craft Shop
124 Ford Ave.
Wyandotte, Mich.

Craftsman Supply House
Scottsville, N. Y.

De Walt Machinery Ltd.
1011 Harrison St.
Oakland, Calif.

Dremel Mfg. Co.
14th and Clark Sts.
Racine, Wis.

Elcraft
1637 Court Place
Denver 2, Colo.

Fanwood Specialties Co.
Scotch Plains, N. J.

Fellowcrafters, Inc.
130 Clarendon St.
Boston 16, Mass.

Frank Maxwell
240 West 40th St.
New York, N. Y.

Fry Plastics Co.
606 South Vermont Ave.
Los Angeles, Calif.

Griffin Craft Supplies
5515 Grove St.
Oakland 9, Calif.

Hobby Supply House
Box 2014
Pittsburgh, Pa.

House Beautiful Plastics
Dept. K2 5534 W. Harrison St.
Chicago 44, Ill.

Leisure Crafts
907 South Hill St.
Los Angeles 15, Calif.

Macy's New York Department Store
Herald Square
New York, N. Y.

Modern Plastics Materials
12916 Grand River Ave.
Detroit, Mich.

National Plastic Products Co.
1349 E. Milwaukee Ave.
Detroit, Mich.

Paterson Brothers
15 Park Row
New York, N. Y.

Plas Met Sales and Engineering Co.
4648 Shirley Place
St. Louis 15, Mo.

Plastics Parts and Sales
1157 South Kings Highway
St. Louis, Mo.

Plax Corp.
133 Walnut St.
Hartford 5, Conn.

Röhm and Hass Co., Inc.
222 West Washington Sq.
Philadelphia, Pa. (for Plexiglas)

Trafford
360 Worthington St.
Springfield, Mass.

The Leather Craft Shop
71 East 4th North Street
Salt Lake City 3, Utah

Universal Handicrafts Service, Inc.
1267 Sixth Ave.
New York 19, N. Y.

U. S. Plastics Corp.
30 Rockefeller Plaza
New York, N. Y.

W. L. Stengaard and Associates
346 N. Justine Ave.
Chicago, Ill.
(Fluorescent Acetate Sheet)

Western Crafts and Hobby Supplies
409 West Second St.
Davenport, Iowa

The foregoing list is fairly complete as of the present time but, if you wish additional sources in your particular vicinity, the classified advertising section of your telephone directory will no doubt be helpful.

For your convenience in obtaining additional information, the following table has been made which lists alphabetically trade names of many plastics. The wholesale manufacturer and chemical groups are also included.

Trade Name	*Wholesale Manufacturer*	*Family or Group*
Bakelite	Bakelite Corp.	Cast Phenolic
Bakelite	Bakelite Corp.	Polystyrene
Bakelite	Bakelite Corp.	Cellulose Acetate
Butacite	E. I. du Pont de Nemours & Co., Inc.	Vinyl Butyral
Catalin	Catalin Corp.	Cast Phenolic
Celluloid	Celanese Corp. of America—Celluloid	Cellulose Nitrate
Cerex	Dow Plastics Co.	Polystyrene
Crystalite	Röhm and Haas Co., Inc.	Acrylic
Durez	Durez Plastics and Chemicals, Inc.	Phenolic Casting Resin
Ethocel	Dow Chemical Co.	Ethyl Cellulose
Ethofoil	Dow Chemical Co.	Ethyl Cellulose
Formica	Formica Insulation Co.	Laminated Plastic
Gelva	Shawinigan Products Corp.	Casein
Geon	B. F. Goodrich Co.	Vinyl Acetate
Geon	B. F. Goodrich Co.	Vinyl Butyral
Geon	B. F. Goodrich Co.	Vinyl Chloride Acetate
Geon	B. F. Goodrich Co.	Cellulose Acetate—Butyrate
Hercose	Hercules Powder Co.	Cellulose Acetate—Butyrate
Insurok	The Richardson Co.	Laminated Plastic
Kodapak	Eastman Kodak Co.	Cellulose Acetate
Koroseal	B. F. Goodrich Co.	Vinyl Butyral
Lamicoid	Mica Insulator Co.	Laminated Plastic

Trade Name	*Wholesale Manufacturer*	*Family or Group*
Loalin	Catalin Corp.	Polystyrene
Lucite	E. I. du Pont de Nemours & Co., Inc.	Acrylic
Lumarith	Celanese Corp. of America	Vinyl Chloride Acetate
Lumarith E. C.	Celanese Celluloid Corp.	Ethyl Cellulose
Lumarith A. C.	Celanese Celluloid Corp.	Cellulose Acetate
Lustron	Monsanto Chemical Co.	Polystyrene
Marblette	Marblette Corp.	Cast Phenolic
Marblette	Marblette Corp.	Phenolic Casting Resin
Micarta	Westinghouse Electric & Mfg. Co.	Laminated Plastic
Monsanto CN	Monsanto Chemical Co.	Cellulose Nitrate
Nixonite	Nixon Nitration Works	Cellulose Nitrate
Nixon E. C.	Nixon Nitration Works	Ethyl Cellulose
Nixonoid	Nixon Nitration Works	Cellulose Nitrate
Nylon	E. I. du Pont de Nemours & Co., Inc.	Polyamide
Phenolite	National Vulcanized Fibre Co.	Laminated Plastic
Plastacele	E. I. du Pont de Nemours & Co., Inc.	Cellulose Nitrate
Plexiglas	Röhm and Haas Co., Inc.	Acrylic
Saran	Dow Chemical Co.	Vinyl Chloride
Styraloy	Dow Chemical Co.	Polystyrene
Styramic	Monsanto Chemical Co.	Polystyrene
Styron	Dow Chemical Co.	Polystyrene
Tenite II	Tennessee Eastman Corp.	Cellulose Acetate—Butyrate
Transflex	Celanese Corp. of America Carbide & Carbon Chemical Co.	Vinyl Chloride Acetate
Vinlite	Celanese Corp. of America	Cellulose Acetate
Vinylite A.	Carbide & Carbon Chemical Co.	Vinyl Acetate
Vinylite V.	Carbide & Carbon Chemical Co.	Vinyl Chloride Acetate
Vinylite X	Carbide & Carbon Chemical Co.	Vinyl Butyral

Plastic accessories and findings are commonly available and will be found to be very useful for many types of plastic projects. The items illustrated in Fig. 8 are typical of those available. Assortments of findings and accessories are very desirable in the craft shop.

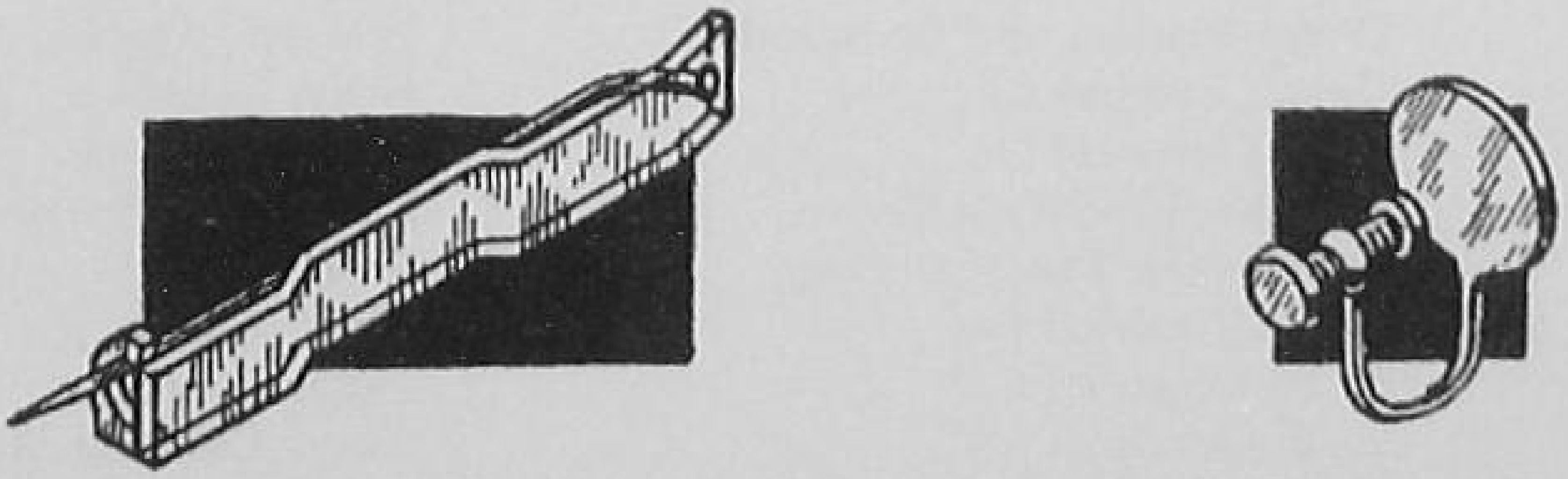


Fig. 8. Plastics accessories and findings. (*Courtesy of Carmen-Blonsson Co., Mount Vernon, New York*).

Some manufacturers of craftwork type power tools are:

Arcade Manufacturing Co., Freeport, Ill.
Atlas Press Co., Kalamazoo, Mich.
Balko Electrical Tool and Supply Co., Chicago, Ill.
Blue Star Products, Fairfield, Ill.
Boice-Crane Co., Toledo, Ohio
Burgess Battery Co., Chicago, Ill.
Casco Products Co., Bridgeport, Conn.
Chicago Wheel and Mfg. Co., Chicago, Ill.
Delta Mfg. Co., Milwaukee, Wis.
Dremel Mfg. Co., Racine, Wis.
Duro Metal Products Co., Chicago, Ill.
Foredom Electric Co., New York, N. Y.
Herbert's Machinery Co., Los Angeles, Calif.
Speedway Mfg. Co., Cicero, Ill.
South Bend Lathe Works, South Bend, Ind.
Syracuse Guild Tool Co., Syracuse, N. Y.
U. S. Electric Tool Co., Cincinnati, Ohio
Walker-Turner Co., Inc., Plainfield, N. J.
Wm. Roemer, New Haven, Conn.

Liquid resin for casting in rubber molds may be obtained from:

U. S. Plastic Craft Corp., 10 E. 49th St., New York, N. Y.
Ettl Studios, Inc., 227 W. 13th St., New York, N. Y.
Stewart Studios, 2927 Wilcox St., Chicago, Ill.

Chapter IV

INTRODUCTION: HOW TO WORK WITH PLASTICS

In general, the utilization of plastic materials in craft work involves the same tools and processes that are common to both woodworking and metal working. Both the experienced woodworker and metalworker will be perfectly "at home" in making plastic articles provided he takes into account certain fundamental characteristics in plastic materials that require special techniques. For those who have had no previous experience in shop work, the fabrication of this material opens up avenues of almost unlimited scope because only the more simple and easily used tools are necessary. The author has experienced one of his greatest "thrills" in teaching from the personal satisfaction and sense of accomplishment of "rank" beginners who have "tried their hand" (with more or less trepidation) in making an article of plastic material. However, the beginner and the experienced, as well, need guidance in this relatively new field and therefore the detailed instruction in fundamental processes which follows should be carefully observed.

It is recommended that Chapter II and III be consulted for advice on choosing a material and for additional information concerning the material you decide to use.

In this section the tools and processes will be introduced by combining the explanation with action pictures of the actual operations. The "usual" method of considering tools, materials, and processes as more or less unrelated study areas has been modified in favor of a teaching method that has been thoroughly tried and has given excellent results for the beginner. In this book, the discussion of tools, processes, and related information concerning material characteristics is brought to the worker *as he needs it* in order to complete a definite project. This type of treatment makes the task of the beginner easy and pleasant. The illustrations are actual photographs showing not only correct techniques but also step-by-step progress leading to the completed article. This does not mean that in following these directions the worker is limited to the exact article illustrated.

Neither does it mean that there is a curb on the originality of design, which is so necessary for complete satisfaction.

The four basic projects for which fabrication directions have been written were chosen to include the most important fundamental hand processes. These four projects are typical of many projects well within the capabilities of the beginner that may be completed by the use of the same fundamental processes. No assumptions have been made relative to the amount of knowledge or skill possessed by the beginner. As far as is possible, all the essential directions and information are included. Any one of the four typical projects may be chosen as the first project. Each process is numbered to facilitate references to it when needed. Each process is explained only once, unless a more advanced technique requires repetition. After having completed one or more of the basic projects the student is in a position to try those processes that are more difficult and require advanced techniques.

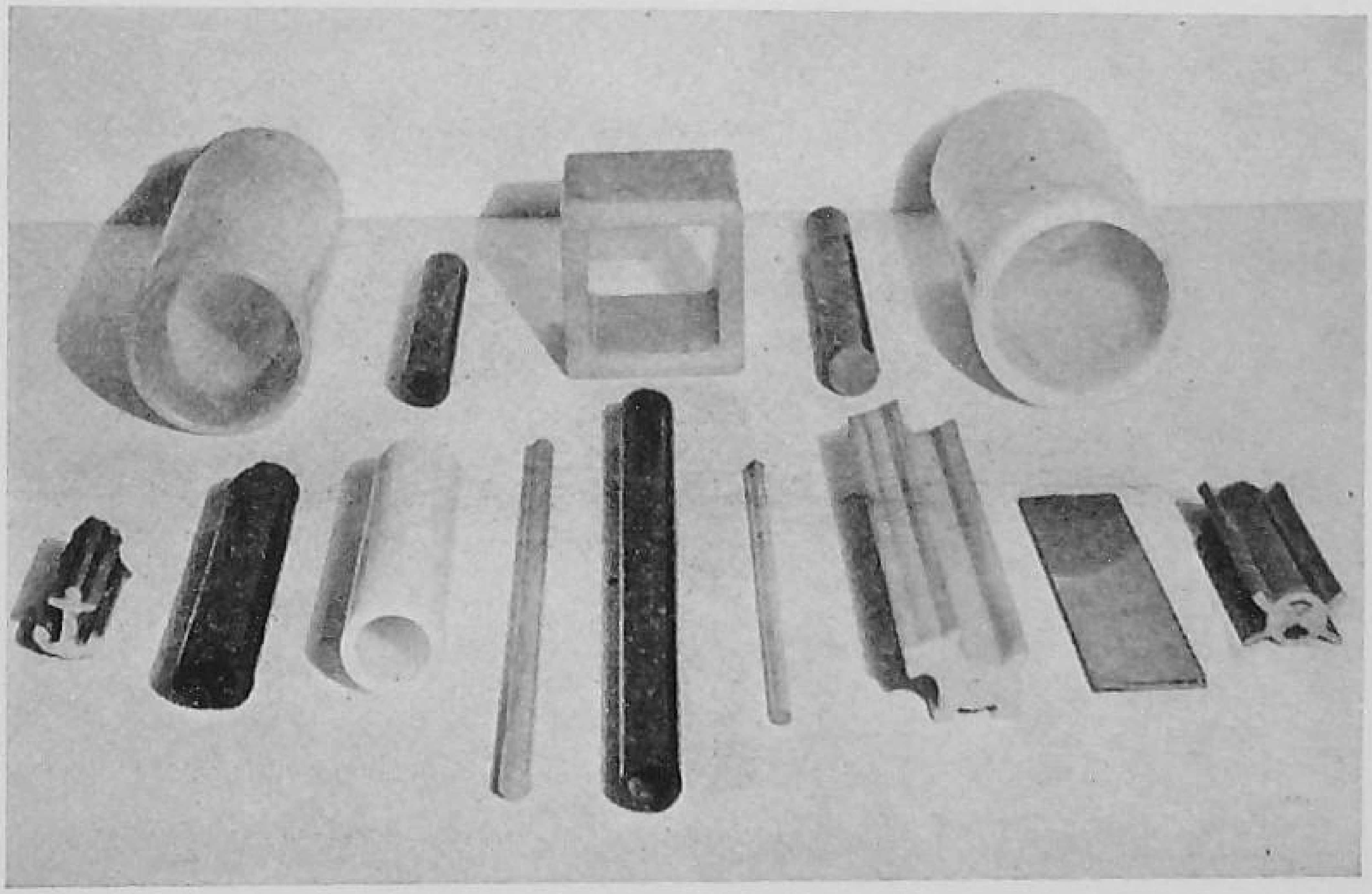


Fig. 9. A few standard shapes and extruded forms.

Fig. 9 shows a few of the many standard shapes and extruded forms available.

Fig. 10 illustrates a few typical elementary projects. Most of these may be made by using the same tools, materials, and procedures that are described in Chapters V to X.

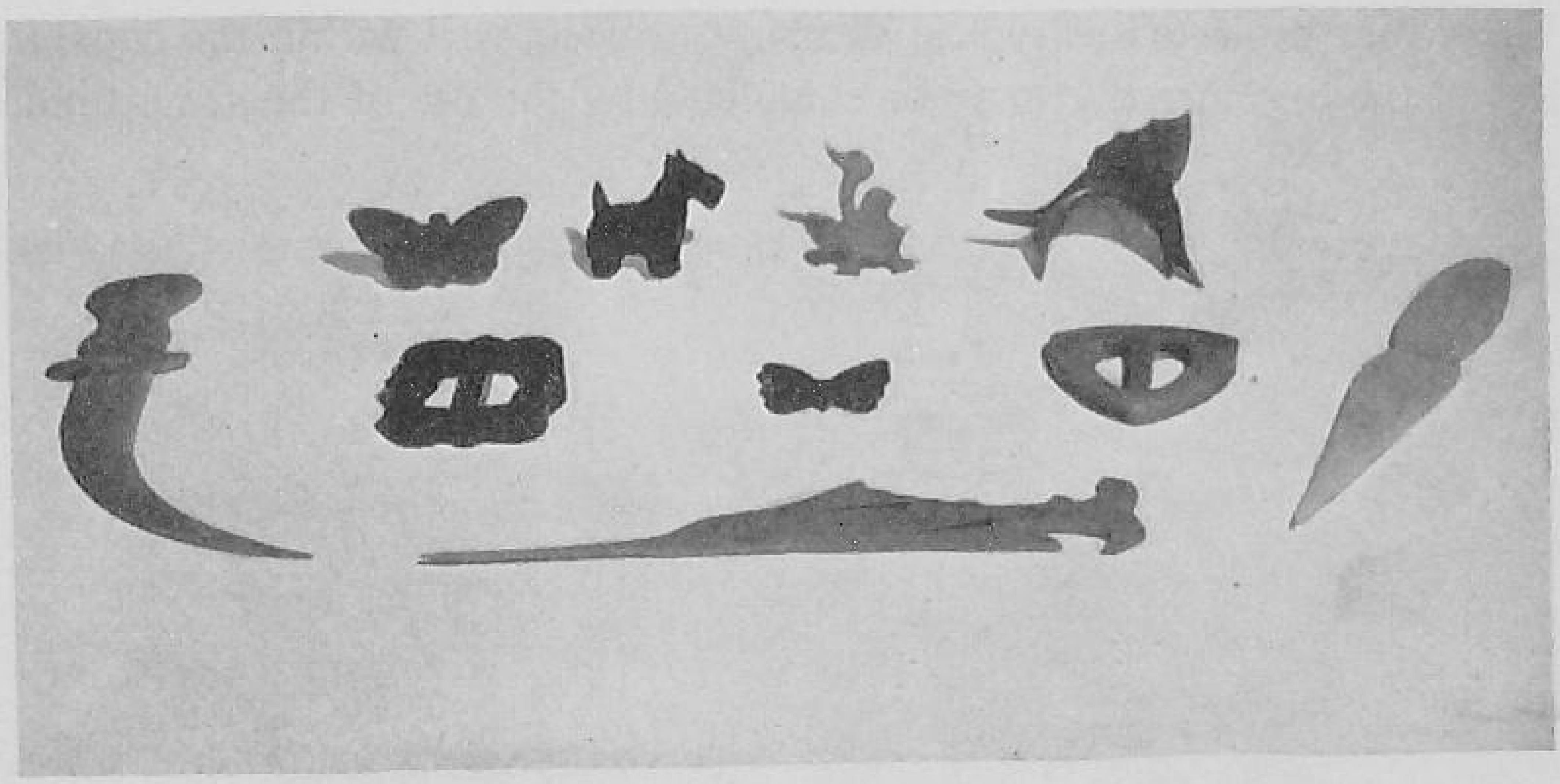


FIG. 10. Typical elementary projects.

Chapter V

PLASTIC PAPER KNIFE

The procedure in making this useful and ornamental article (Fig. 11) includes many important and fundamental processes common to the making of nearly all plastic projects. It will, therefore, be used as the first

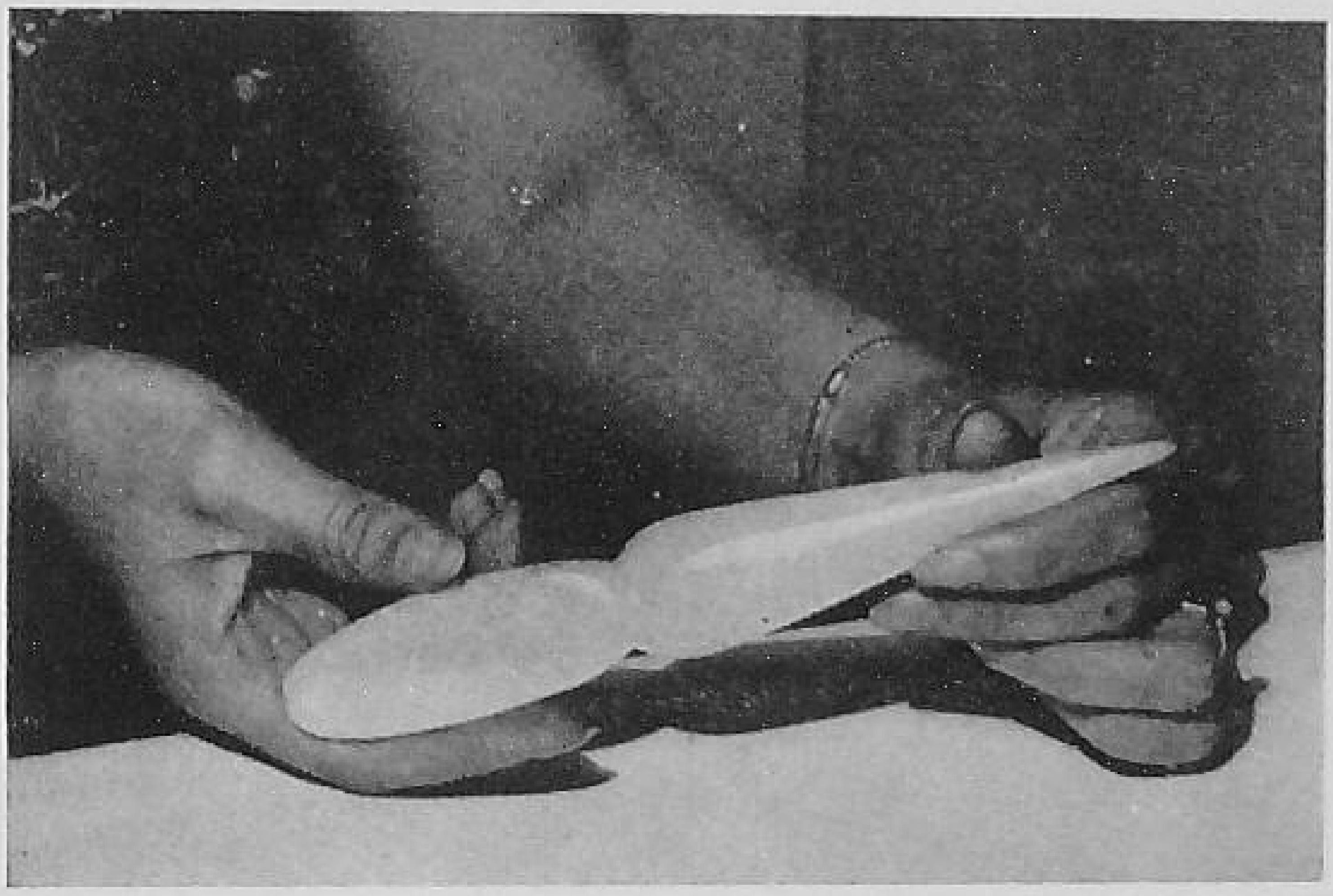


FIG. 11. Paper knife.

project to introduce tools and processes considered to be essential for the beginner. This article is commonly made from cast phenolics, acrylics, or cellulose type plastics.

Process No. 1. Choosing the Design

The choice of a suitable design for any plastic project is greatly influenced by many factors, among which are cost and type of the materials to be used, the type of surface ornamentation desired, and the manner in which the article is to be utilized. No complete discussion of design principles is possible in this short treatise. However, there are a few general principles that should be kept in mind. The design should incorporate originality with simplicity and balance. The fundamental purpose of the

article must not be secondary to the design. Decorations should be sparingly used and colors that provide both contrast and harmony should be chosen. The plastic material is in itself very decorative and beautiful. It needs no striking ornamentation. Do not use an overabundance of material. Usually neither parts used for structural strength nor parts used for surface enrichment require massive and heavy proportions. The following color chart may prove interesting to those interested in the meaning of various colors.

Color Meanings

Red	Fire, heat, excitement, strength	Light Green	Freshness, crispness, coolness
Rose	Daintiness, softness, fragrance, freshness	Purple	Royalty, stateliness, opulence
Orange	Warmth, action, power, tastiness	Lavender	Fragrance, richness, refinement
Maroon	Richness, solidity, luxury, quietness	Brown	Wholesomeness, mellowness, utility
Yellow	Brightness, airiness, refreshment	Gray	Mildness, softness, reserve primness
Dark Blue	Coldness, formality, haughtiness	White	Purity, professionalism, cleanliness, chastity
Light Blue	Coolness, fragility, daintiness, youthfulness	Black	Strength, mystery, heaviness, coldness
Dark Green	Unhealthfulness, cheapness, coldness		

With plastic materials, the design can be rendered by a variety of methods. Some of the common ones are: Cutting the design lines into the surface (engraving), cutting away the design background to leave the design in relief (carving), cementing letters or figures to the surface (overlay), or cutting holes directly through the article (piercing). These methods of ornamentation and many others will be described later.

A plain paper knife with no surface enrichment has been chosen for this beginning project. This article is to be used as a letter opener and, therefore, the size and shape must be adequate to do this particular job. The surface ornamentation here would be of secondary importance in the sense that it may be selected to suit the taste of the maker. The surface enrichment may be rendered in a manner limited only by skill of the individual and the available tools. It is customary to draw the layout on tracing paper and it is usually helpful to make cardboard patterns of each piece involved in the project.

Fig. 12. Using a marking gage.

Fig. 13. Using the combination square.

Process No. 2. Laying Out

The layout consists of straight or curved lines drawn on a surface. Some lines may show the location of hole centers and the location of centers of curvature for curves which are arcs of circles. The outline and design lines are considered to be part of the layout. After the size and shape of the project have been determined, the next step is to obtain a piece of the plastic sheet stock of just sufficient size to make the article. It is common practice to buy plastic material by the sheet and, rather than risk injuries to the entire sheet while making a project, it is advisable to cut a piece from the sheet which will be the right size for the job at hand. Some of the plastic sheet material, such as Plexiglas and Lucite, has masking paper covers on each side. This covering material should be left on as long as possible to protect the polished surfaces. The layout may, in this case, be done with a pencil on this protecting cover. Be sure not to waste stock. Save all small pieces for future use.

Fig. 12 illustrates the use of a marking gage to mark a line parallel to, and at the desired distance from, a straight edge. The most common type of marking gage has a metal point, or spur, sharpened to a wedge shape. The point is slightly sharper on the front edge and is set so that, as the mark is made, the gage is drawn against the working edge of the stock. The distance of the mark from the edge may be set easily by utilizing the scale on the sliding member which carries the marking point. For accurate work, this setting should be checked with a scale.

After the edge lines are completed, a second line that marks the length of the piece and insures a square corner is made with the aid of a *combination square* and a *scratch awl*. The combination square consists of a cast-iron head and a 6″, 9″, or 12″ blade which slides through the head (Fig. 13). The head makes a 90 degree angle with the blade on one side and a 45 degree angle on the other. Many of these squares have a level glass on the head and are fitted with a scratch awl. Other uses of the combination square will be described later. The *scriber*, or *scratch awl*, is a sharp steel point mounted in a suitable handle. It is used to scratch layout lines into a surface.

Process No. 3. Sawing with a Hack Saw

The sheet of material is clamped to the surface of a bench with a "C" clamp. Be sure to protect the sheet with a piece of soft wood so that the pressure of the clamp will not dent it. Adjust the edge of the sheet to project out from the edge of the bench just enough to allow sawing just

outside the layout lines. The *hack saw* consists of a frame holding a steel blade hardened to cut metal (Fig. 14). The frame is often adjustable to take blades from 8″ to 12″ long and is made with various devices to keep the blade under tension. The blades are commonly made of carbon tool steel or tungsten alloy steel and are very hard. The number of teeth per inch, called the pitch, ranges from 14 to 32. Saw the layout lines with a

FIG. 14. Sawing with a hack saw; blade rotated 90 degrees.

medium or fine pitch blade (24 or 32 teeth per inch). Do not force the saw. With the correct amount of pressure it will go quickly and easily through the material without clogging or heating.

The saw cut may be started with the blade in the normal position. In Fig. 14 the blade has been rotated 90 degrees with respect to the handle and in this position the saw cut may be continued to the extent of the layout line without interference from the handle and front end of the saw frame. The hack saw is only one of the common hand saws which could be used to do this job. The use of other saws will be described later.

Process No. 4. Transferring the Design

After a suitable design is drawn or has been selected from a design book, or other sources, it may be transferred to the plastic surface by either of two common methods.

Method A.

Trace the design on a piece of tracing paper (transparent paper) large enough to allow folding its edges around to the back of the plastic piece (Fig. 15). Rub with the finger a thin coating of whiting on the top of the

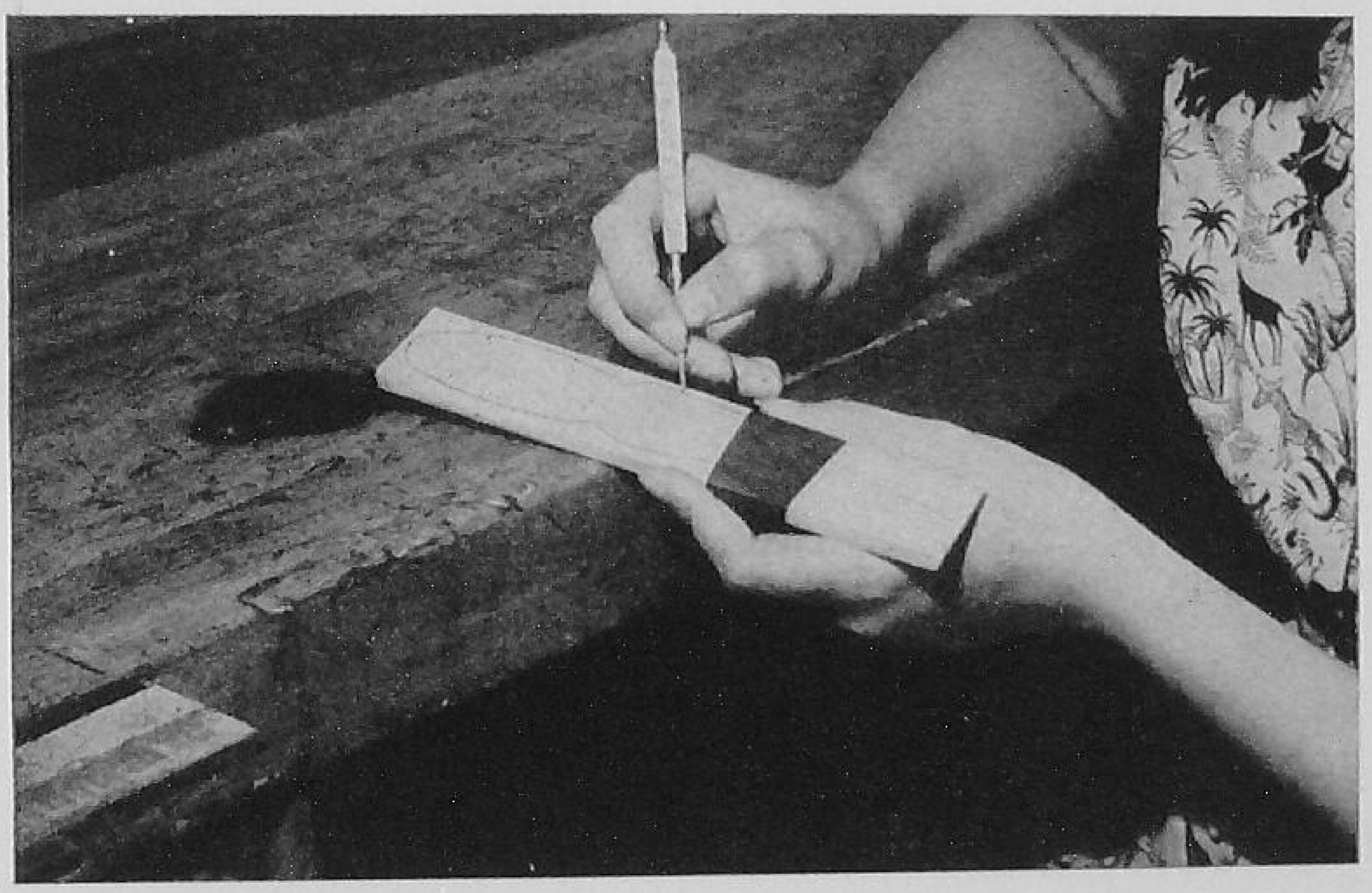


FIG. 15. Transferring the design: Method "A".

plastic surface. A good whiting solution may be made from 1 part whiting, 5 parts water, 1 part alcohol, and a drop or two of liquid soap. If a brush is used the solution must be very thin. Only a very thin coating of the solution is required.

Place a piece of carbon paper (with its carbon side down) on the whitened surface and adjust and fasten the tracing paper in the correct position. This is accomplished by folding the edges of the tracing paper around the edges of the plastic piece to the underside where they are secured with masking tape. Using a pencil or a blunt steel point, trace the design on the whitened surface. Remove the tracing paper and carbon paper and scribe

the design into the plastic surface with a scratch awl. Wash the whiting off with soap and water.

Method B.

This method involves the use of a *template* and is most useful in transferring the outline of projects to the plastic surface. A *template*, or pattern, is made of a stiff paper, cardboard, or thin metal sheet cut to the exact size

FIG. 16. Template cemented in place.

and shape of the project outline. Squared paper is often used in laying out a template. The squares help in keeping the outline symmetrical with respect to a center line and are also helpful in copying a design which is to be changed in size. The template is fastened to the plastic piece with rubber cement (Fig. 16) and used as a guide for the scratch awl while marking the outline on the surface. The template may be left on while the outline is being sawed but is usually removed before filing to the scribed lines.

After the outline of the template has been scribed into the plastic surface (Fig. 17), it is ready to be sawed out. Various other common tools that may be useful in layout work are also shown in Fig. 17.

The *dividers* resemble a compass but both legs are metal and pointed. They are used to transfer measurements, to scribe circles, and to lay out arcs. The *French curve* is used as a guide in laying out irregularly curved lines. The *hammer* and *center punch* are used to make small conical shaped impressions. These serve to locate the centers of holes, or for a center position while scribing a circle with the dividers. The *steel scale,* also called

a steel rule, is made of a thin strip of hardened spring steel. It is usually graduated in 32nds or 64ths of an inch. The better grade scales are graduated on both sides.

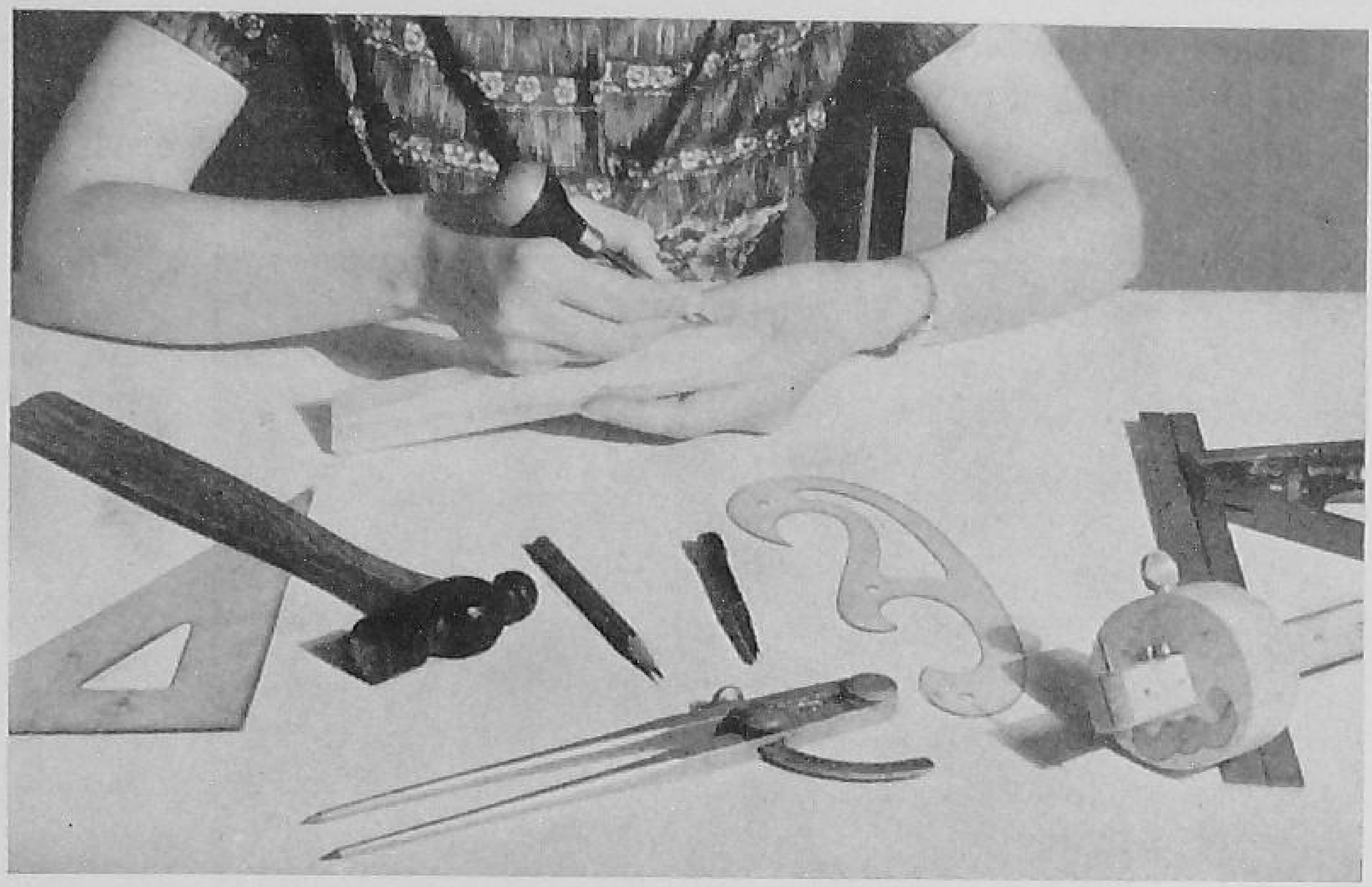


FIG. 17. Scribing the outline.

Process No. 5. Sawing with a Jeweler's Saw

The jeweler's saw has a strong steel frame with clamping jaws to hold a 5″ metal cutting blade (Fig. 18). It is designed to saw thin sheet metal and may be obtained with a frame ranging from 2¼″ to 12″ in depth. The frame is adjustable to obtain the necessary blade tension. Blade Nos. 1–4 with about 22 teeth per inch will be right for all but the very small radii curves. The blade should be inserted in the saw frame with the sharp points of the teeth pointing toward the handle. The saw should be pulled downward on the cutting stroke. This will cause the piece being sawed to be pulled on to the support. Also the blade will retain good tension because the added pull while sawing is on the rigid handle portion of the frame rather than on the relatively springy other end. The work is held on a V-saw support which may be of the simple type shown clamped to the bench in Fig. 18 or it may be made with a right-angle extension which is clamped in a metal or wood vise. The saw is moved up and down in a vertical path. Make sure that the saw blade is kept at right angles to the

surface being cut. The line along which the saw cut is to be made should be lined up closely to one side of the V-support. This will avoid bending the material and the consequent breaking of the saw. Practice moving the saw up and down with an easy relaxed motion. There is no recognized "best" manner of gripping the saw handle, although the grip shown in Fig. 18 is commonly used. Make sure that the blade has proper tension; otherwise it is difficult to saw a line and the blade will become distorted and

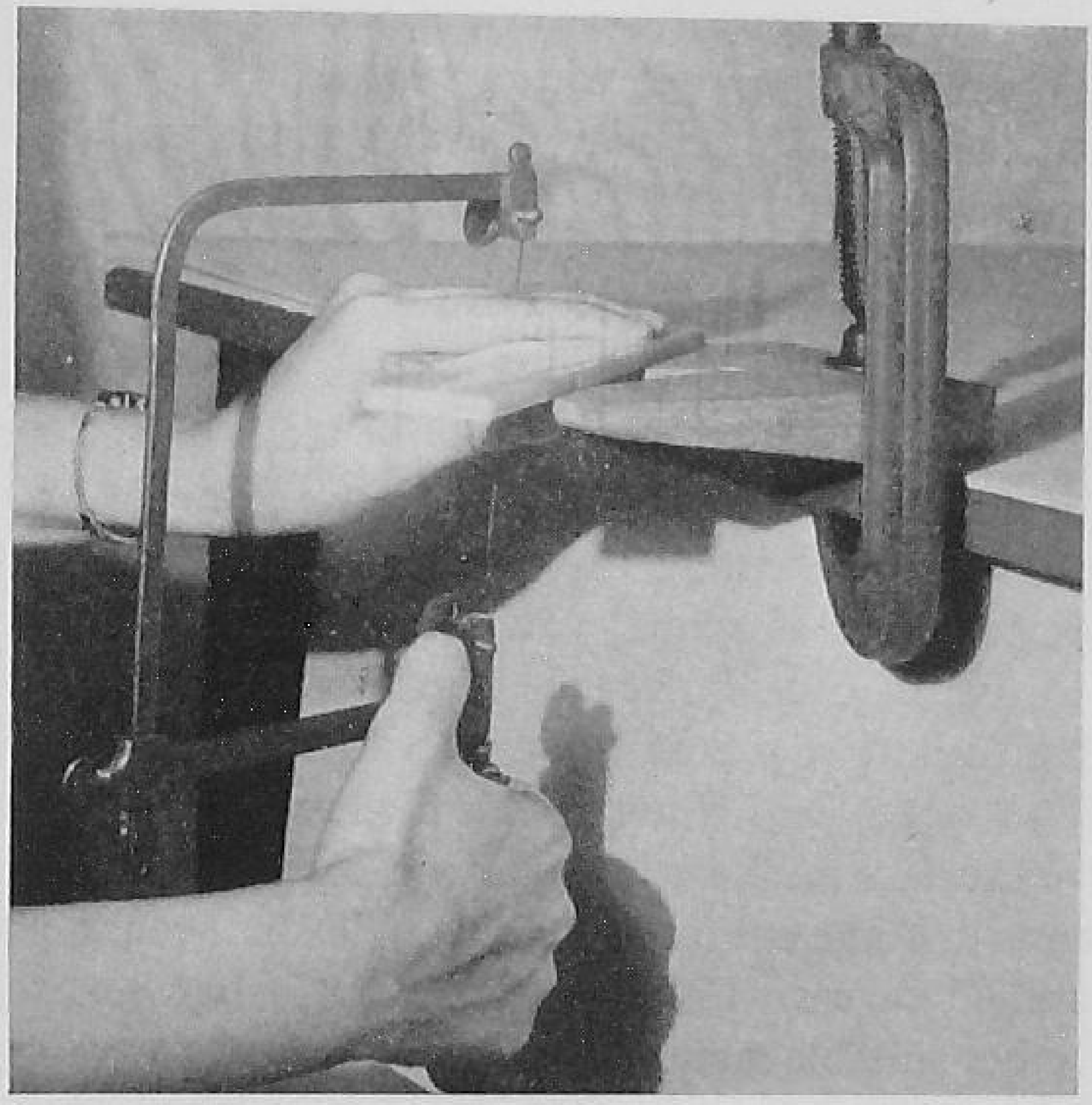


FIG. 18. Sawing with a jeweler's saw.

may be easily broken. The work may be held on the V-support with a "C" clamp provided the material under the clamp is protected with a softwood pad. Usually, however, it is necessary to change the position of the piece many times during the sawing process and most craftsmen hold the piece in place with the thumb and two fingers of the hand not occupied in moving the saw. Start the saw cut while the saw motion is being maintained but use only a minimum of pressure against the work. Let the saw do the work while you supply the motion. Apply just sufficient lateral pressure to maintain easy sawing conditions. Be sure to saw outside the design lines. Leave a little material to be filed down to the line. How much

to leave outside the line is dependent upon how proficient you become in following the lines. In any case, enough material must be left so that, when the sawed edge is smoothed by filing and sanding, the design line will have just been reached and obliterated.

For sawing out portions of a design in the interior section of the material it is necessary to drill a hole in the position to be cut away. It is a good practice to make a very light center punch mark or, better still, a deep scratch awl indentation. This will locate the position of the hole and lead the drill point into the correct location. *Caution:* When using a center punch it is important to strike it with a very light blow; otherwise there is danger that the plastic sheet may crack. For the method of drilling a hole, see Process No. 17.

Process No. 6. Filing with Hand Files

The sawing process leaves a rough, coarse surface which should be trimmed off with a file. Files are made with teeth of various degrees of fineness. The spacing between the teeth and the angle at which these teeth cross the surface determine the "cut" of the file. They are made in a variety of shapes, such as round, flat, square, half round, or triangular. Which file to use, of course, depends upon the kind of surface and the material being filed. For plastic work probably the most useful type is a half-round file about 8″ or 10″ long. This file has a flat surface on one side and the curved surface on the other. Use a file with a coarse cut for rough work and one with a fine cut for smoothing. The half-round portion allows filing on "inside" curves. Hold the paper knife between two pieces of softwood or other suitable material and clamp it in the wood or metal vise. The portion upon which the filing is to be done should be held quite close to the vise jaws so that it will not chatter or bend during the filing operation.

Fig. 19 shows an edge of the paper knife being filed down to the design line. Be sure to guide the file in slow, steady strokes and in a direction such that the filed edge which results is at right angles to the plastic surfaces. Remember the file cuts only on the forward stroke and, therefore, should be lifted, or at least the pressure should be released, on the backward stroke. Keep the file clean with a file card. Never use a file without a handle. To obtain an extra-smooth, even surface, a process known as *draw filing* is commonly used. The file is grasped at each end and moved in a direction perpendicular to its length across the work. This process will be helpful to the beginner in truing up the edges of the paper knife.

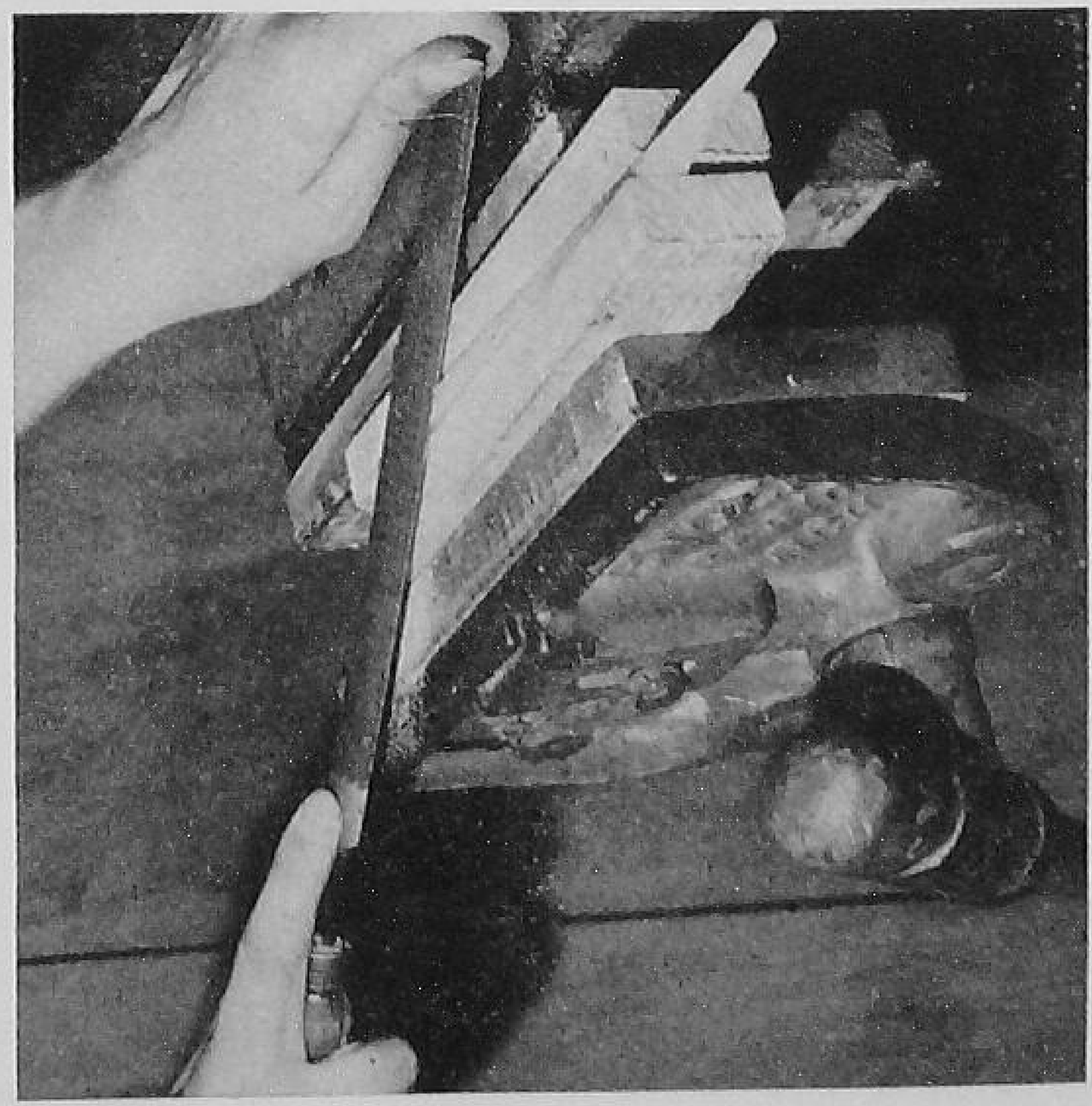


FIG. 19A. Filing an edge in the wood vise.

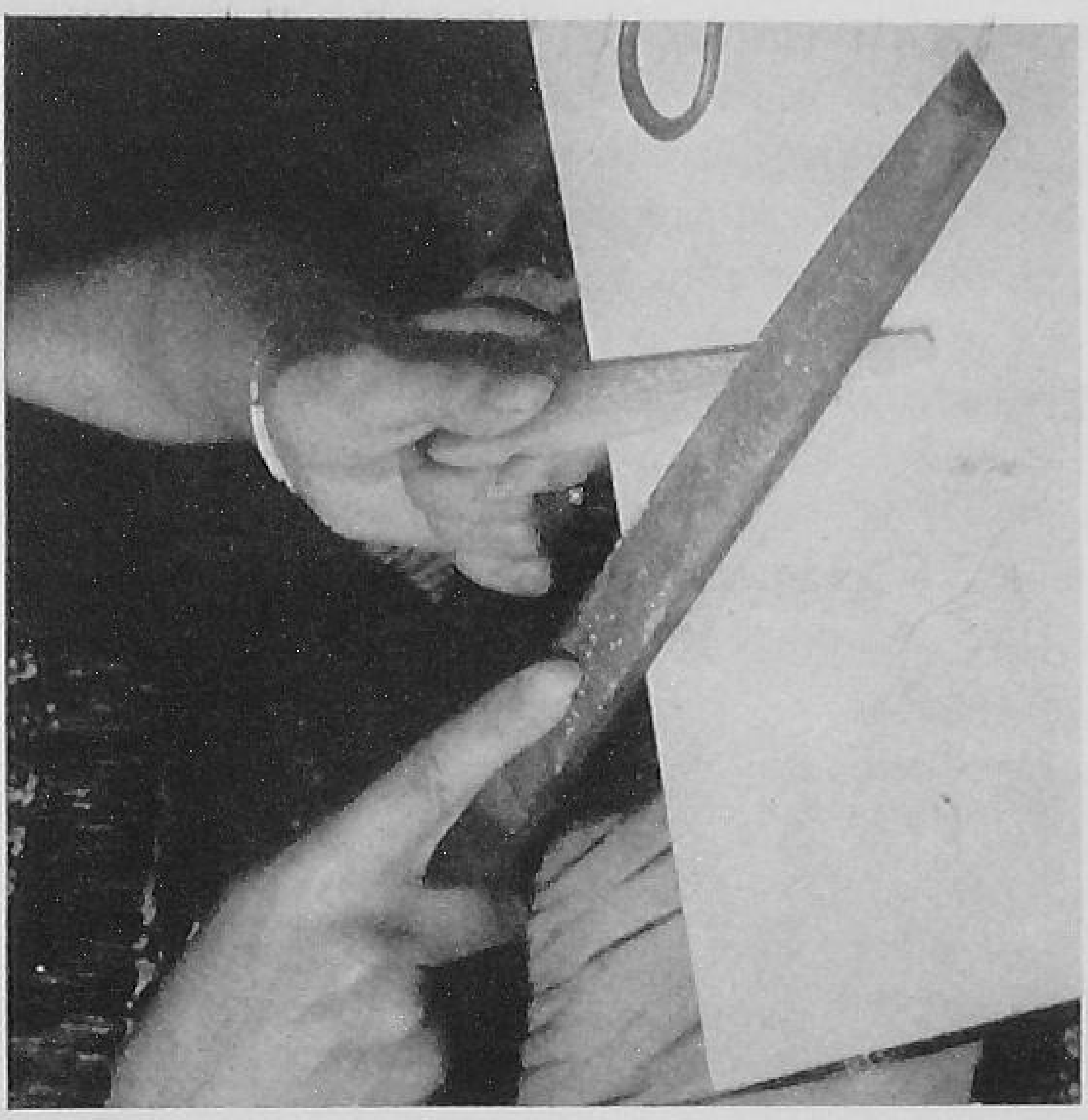


FIG. 19B. Filing the knife edge

Round off all sharp edges to the degree desired using the smooth cut file to avoid chipping. Be careful not to touch the polished surfaces which do not require filing. File marks must be removed and each mark will require additional work and time in the finishing process. After the edges have been completed, the cutting edge or edges are filed. Do the roughing with a coarse-cut file and then smooth the surface with a fine-cut file. Do not allow the cutting edge to become too thin.

Process No. 7. Filing with Jeweler's Files

Jeweler's files are sometimes called needle files. They are small files made for delicate and exact jobs. They are made in a great variety of

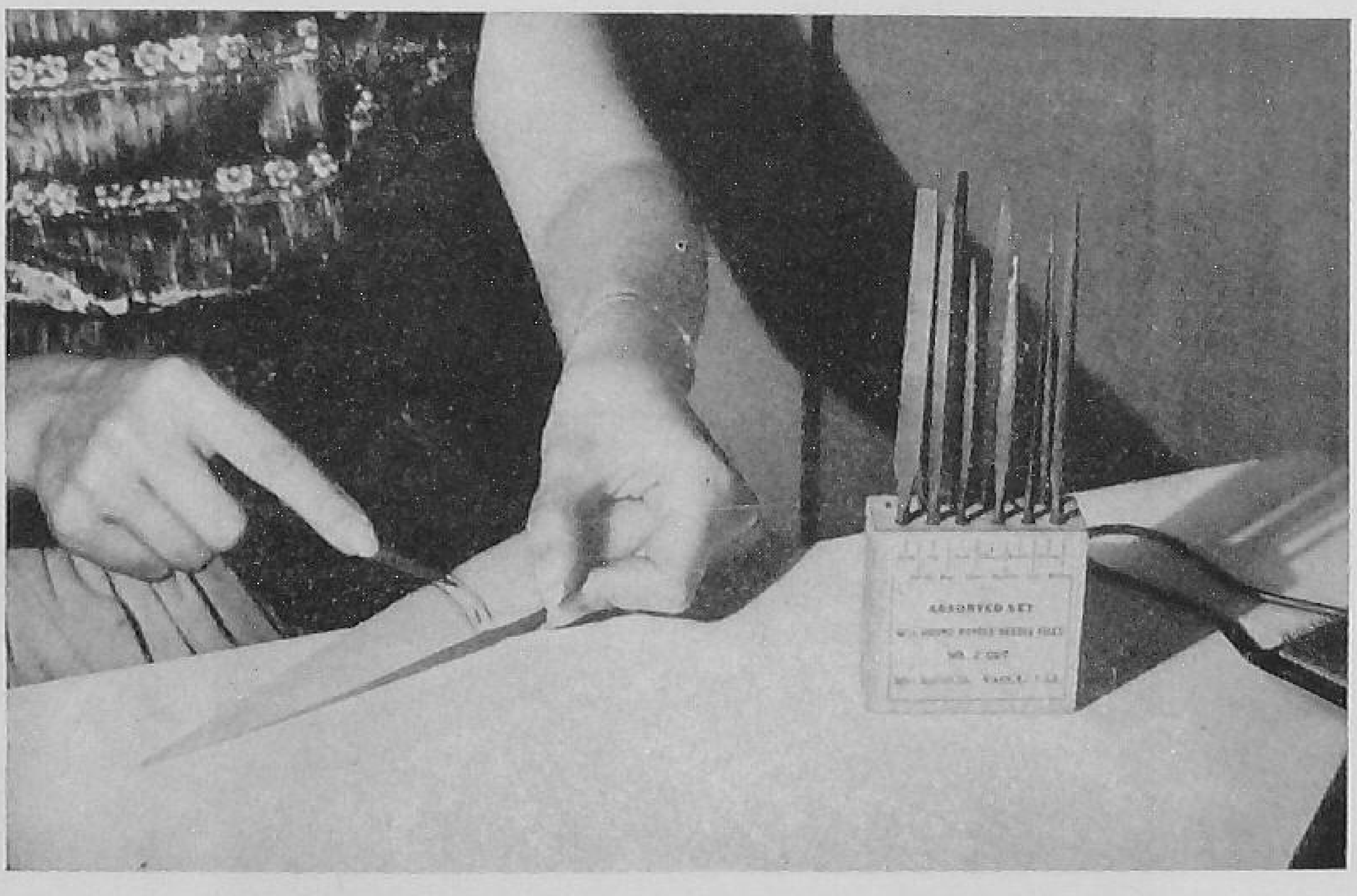


FIG. 20. Filing the neck with a jeweler's file.

shapes and are usually sold in sets. They range in length from 4″ to 6″, with round or square handles. The files of this type are made with a fine cut and consequently should be used as a smoothing file for plastic work. Wherever possible the roughing processes should be done with a coarse-cut file. Fig. 20 shows the neck of the paper knife being filed to the layout lines. The exact shape and width of the neck should be determined and layed out with pencil or scratch awl prior to filing. In general, the jeweler's file chosen for a particular job should have a contour corresponding as

FIG. 21. Sanding an edge.

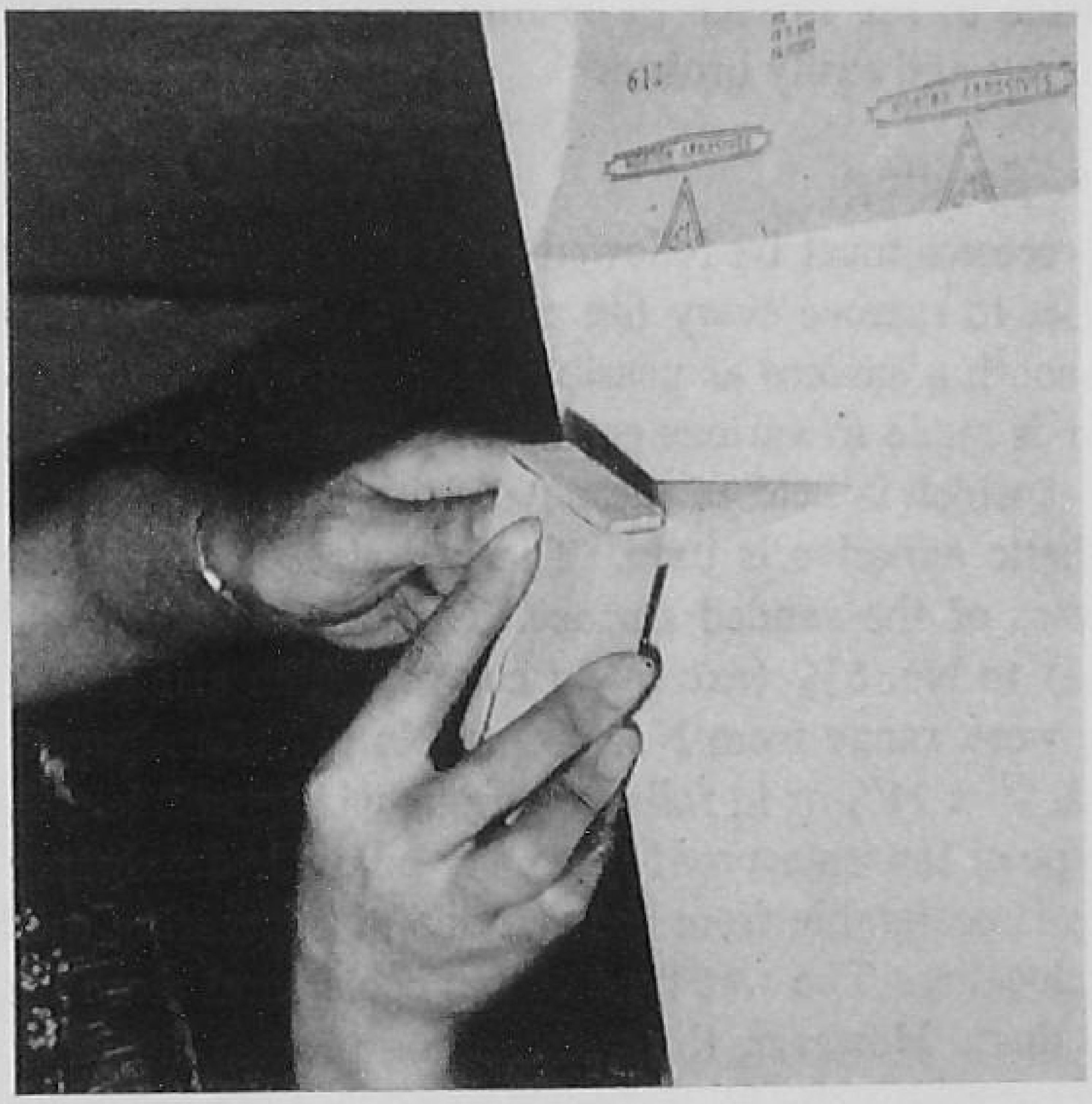


FIG. 22. Sanding the knife blade.

nearly as possible to the surface to be finished. Do not force these files. They are expensive and easily broken.

Process No. 8. Sanding

The filing processes must be followed by a thorough sanding, first with coarse sandpaper to remove every file mark and then with fine sandpaper to obtain as smooth a surface as possible, preparatory to the buffing process. Sandpaper is made in various grades of paper or cloth. The abrasive is flint or garnet which is held to the paper with glue. For the waterproof variety a synthetic adhesive is used. The grit size of the abrasive determines smoothness of the sanded surface. Grit sizes range from No. 8–0 (extremely fine) to No. 3½ (extremely coarse). The grit sizes ordinarily used in plastic work range from No. 6–0 to No. ½. Sandpaper comes in standard sheets, 9″ x 11″, or in rolls of various widths and lengths. Either the ordinary type or the waterproof type may be used. Sandpaper with the garnet abrasive is preferable from the standpoint of wearing qualities and freeness from clogging. The wet type allows cooler and more free cutting and eliminates dust. However, the wet sanding process is rather messy if carried on at the workbench and a special stand and other facilities should be provided.

While sanding the edges of the paper knife hold it in the vise in the same position as for filing (Fig. 21). The sandpaper should be folded around a small block of wood and used in a manner similar to draw filing. The block insures adequate pressure, prevents the sandpaper from wrinkling, and allows a true surface to be sanded without rounding off the corners. The knife edges are also sanded with the aid of a block. All sharp curves may be sanded by folding the sandpaper over a half-round file of correct size, or a piece of wooden dowel (round rod) (Fig. 21). The rounded corners may be conveniently smoothed by sanding with a folded piece of sandpaper held in the hand. Fig. 22 illustrates the method of sanding the knife blade.

Process No. 9. Buffing (Rough Polishing)

This process is used to remove sandpaper marks and obtain a bright, shining, mirrorlike surface. The individual pieces of an "assembly type" article are usually buffed before assembly as this procedure is easier and the results are better. Buffing is ordinarily done by cloth wheels (buffs) to which an abrasive is applied and which are rotated on a spindle. The abrasive powders are usually mixed with a waxy substance and formed into

sticks for convenience in applying to the buff. The common abrasive powders are emery, tripoli, and diamond dust (named in the order of decreasing coarseness.) There are many commercial abrasive powders

FIG. 23. Buffing with a linen buff. (Dark abrasive compound is "tripoli"; light abrasive compound is "diamond dust").

manufactured under various trade names, most of which will serve the purpose very well.

It is important to have at least two and preferably three different grades of coarseness so that the buffing can be accomplished in a minimum of time and effort. The coarse abrasives cut away the surface material many times faster than the fine ones. The wheels consist of circular disks of cloth sewn together with a hole in the center which allows them to be mounted on a tapered spindle provided with a coarse thread. The felt buff is quite solid and in plastic work is used only for removing deep scratches. The canvas or linen buffs are generally used with the coarse abrasives, such as emery or tripoli. The cotton buff is reserved for the polishing process which follows the buffing. In plastic work a comparatively soft buffing wheel is a necessity and it is common practice to cut the outer row of stitching which holds the buff together in order to obtain the softness and pliability that are so necessary. This also allows the buff to get into sharp corners and crevices. Some craftsmen even cut away every other cloth disk outside the stitching to obtain a similar result.

The buffing process may also be done by using a wet type wheel with pasty or "mud-like" abrasive. In this case the process is called *ashing* and, although it is an efficient method of buffing, it calls for a special boxed-in wheel to prevent the abrasive from being thrown toward the operator. The ashing mud consists of No. 00 pumice and water mixed to a thick paste. For ashing, a 6″ buff should be run at about 3500 r.p.m. For the beginner the dry type buffing process will serve nicely.

For both the dry and wet type buffing processes, a face shield is a necessity (Fig. 23).

There is another method of buffing that is done entirely by hand (Fig. 24). In this case a piece of felt or flannel is glued or otherwise attached to a flat stick and the abrasive is applied to the flannel and rubbed on the plastic surface. A soft shoebrush charged with abrasive compound will also serve. For polishing pierced articles or corners which the rotary buffs will not reach, a special technique is often used. Take the saw blade out of a coping saw frame or jeweler's saw frame and tie a stout cord (under tension) in its place. Charge the string with the appropriate buffing compound and use the string as a buffer. A leather thong works well.

When using the power buff, the piece being buffed is held on the underside of the revolving buff and is pressed into the buff with a firm, rolling motion. This prevents the fine surface lines which would appear if the surface were held in one position. The revolving buff must not be allowed

to catch on the end nearest the hands, because the piece will be pulled violently out of the hands and very likely will be scarred when it hits the wheel guard. The spindle speed depends upon the size of the wheel, the kind of plastic, and the type of buff, but, in general, a speed of about 2500 r.p.m. is satisfactory. A motor of at least $\frac{1}{3}$ hp. is recommended. To obtain good results the buffs must not be allowed to become clogged with the abrasive. The end of an old file held at an angle against a revolving

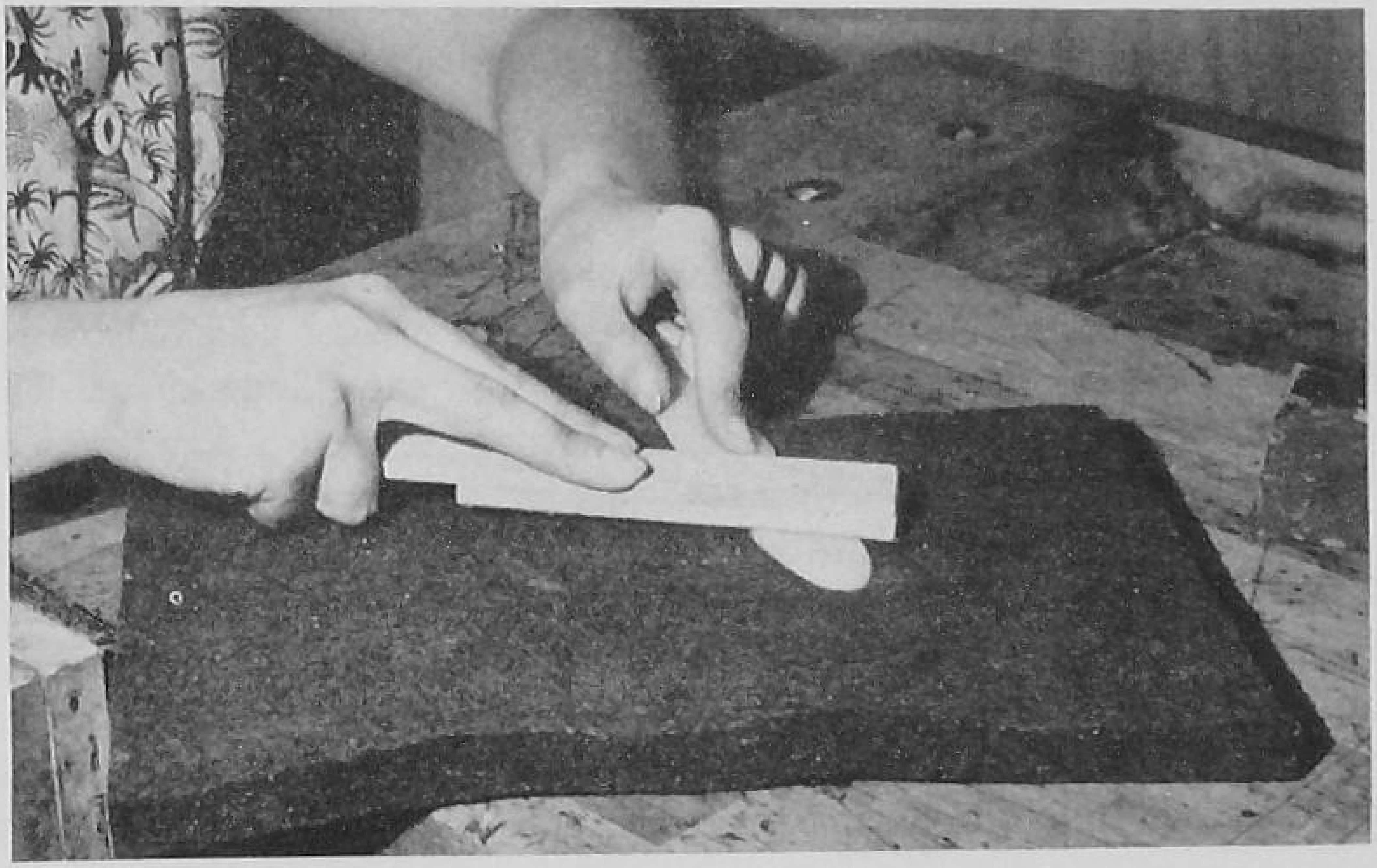


FIG. 24. Hand buffing.

buff will clean it. It is essential that the wheels be used with only one grade or coarseness of buffing compound. After once being charged with a coarse compound, a wheel is useless for fine work. A bath (and subsequent drying) in carbon tetrachloride or benzine will help rejuvenate an old clogged buff.

Fig. 23 shows the buffing process used on the paper knife. In Fig. 23, a linen buff is being used with a tripoli buffing compound. The buffing is continued until the surface is as smooth as possible and then the wheel is changed to a soft cotton type which is charged with diamond dust or its equivalent. Be sure to hold the piece securely and be very careful to avoid excessive pressure. It is easy to burn plastic material and once burned it is very hard or impossible to repair. If necessary, or more convenient, support

the piece with a small flat stick (called a paddle). The surfaces which are to be cemented and which are not to be visible after assembly are not buffed because, in general, the cement holds better on a roughened surface. This does not hold true however, where the pieces to be joined are of transparent material. In this case the joint surfaces may be buffed to avoid a cloudy region at the cemented joint. For this type joint, the cement will usually be of the transparent, colorless type.

A mirrorlike surface should result from the buffing procedure and many craftsmen consider that buffing provides a final surface which is quite suitable. Usually, however, the buffed surface may be improved by the process of polishing, which follows.

Process No. 10. Polishing

It is not always clear to the beginner when the buffing process ends and the polishing begins. In plastic work the buffing process should have removed all the sandpaper marks and produced a bright, shiny surface. The piece should then be washed with soap and water to remove any traces of the last used abrasive. It is then ready for polishing, which may be done with a very fine abrasive or with a clean, soft buff without abrasive. The best method in any particular instance is determined by a little experimentation, some materials responding differently from others. In case you use an abrasive be sure to have a very fine one, like rouge or whiting, and a very clean, soft wheel. Only a few passes on the wheel are necessary or desirable. There are also some greaseless polishing compounds that work well.

If no facilities for machine polishing are available, this process may be done by hand but by the expenditure of quite some energy. The common method is to rub the buffed surface with a soft cloth or a chamois-wrapped dowel until the desired polish is obtained. The hand method, however, seldom brings the same brilliance that is possible with only a few passes on a power buff. Some substances that have been used as an aid in hand polishing include hair oil, tooth paste, tooth powder, floor wax, lard, and other forms of wax polishes. The polishing process adds brilliance and tone and is the "crowning achievement" without which full satisfaction is not obtained. Some craftsmen use a thin coating of wax, such as Simoniz, to obtain high polish and to protect the surface. If you prefer this finish, be sure to use only a very thin coating; otherwise some cloudiness is likely to result.

Fig. 11 shows a paper knife after having been polished.

Chapter VI

PLASTIC RING

The second project which has been chosen as representative of the type that is simple and yet interesting is a plastic ring. In making rings there is almost no limit to the beautiful combinations of colors, ornamentations, and shapes that are possible. The one illustrated (Fig. 25) was made from

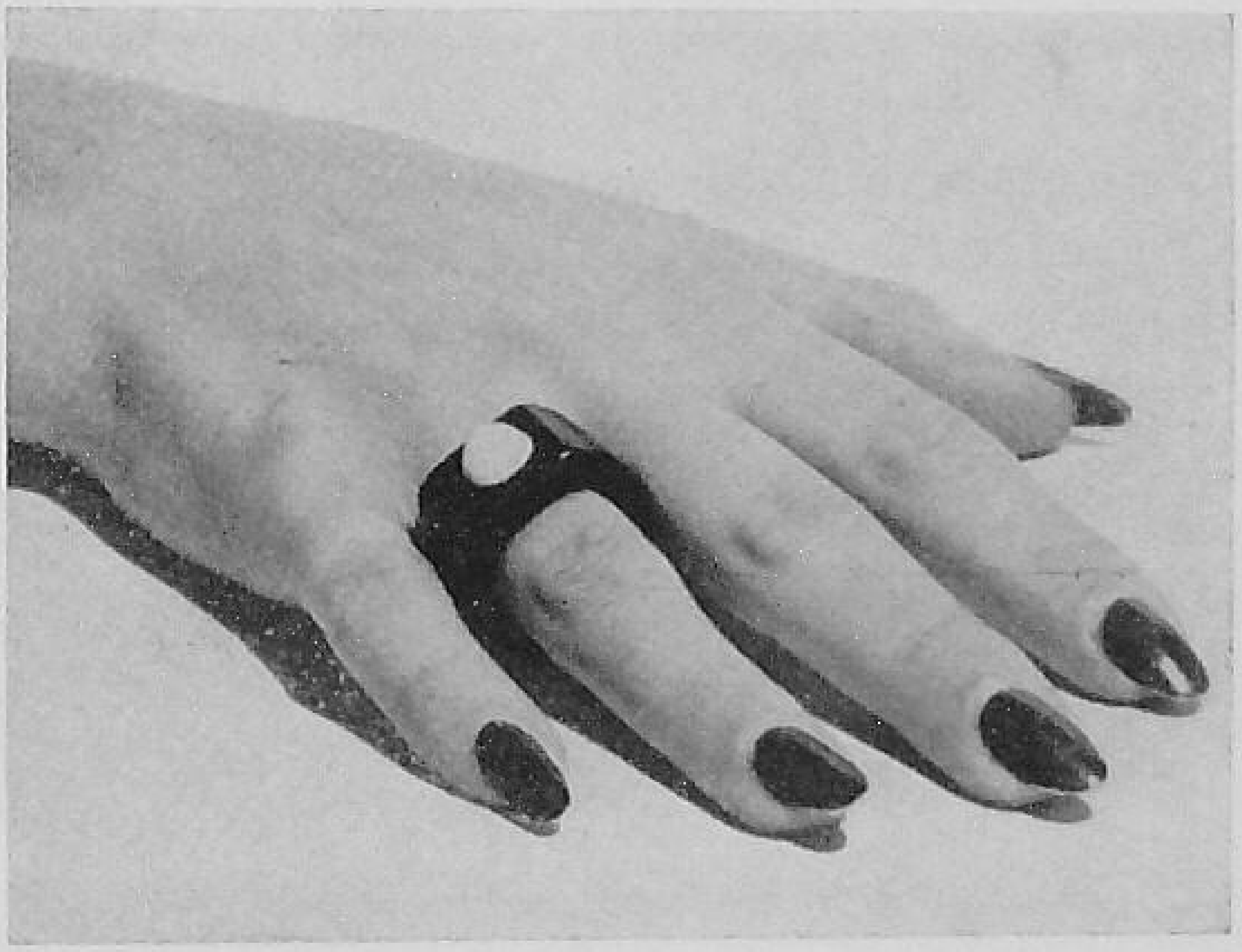


Fig. 25. Ornament cemented in place.

an "extruded" rod of ring-shape material of the cast phenolic type (see Fig. 9). The "ring rods" are available in several shapes. They have a tapered inside hole which allows one to cut off a piece which will need only a minimum of shaping to obtain the desired size. The ring could have been made from a solid block, but the labor involved, and the fabricating difficulties, would have been greatly increased.

Process No. 11. Sawing with a Backsaw

Mark out the correct width for the ring on the rod you have chosen. This may be done with a pencil or a scriber. Then saw the block from the

rod by holding it on a device called a "bench hook." This simple but handy device is made from a piece of wood about ¾″ thick, 10″ long, and 5″ wide (Fig. 26). A small strip about 1″ square is nailed or screwed across the top surface at one end and another like strip on the bottom surface at the other end. One strip hooks down over the end or the edge of the workbench while the other serves as a support for the piece being sawed. The reason for using this device is to avoid the danger of breaking

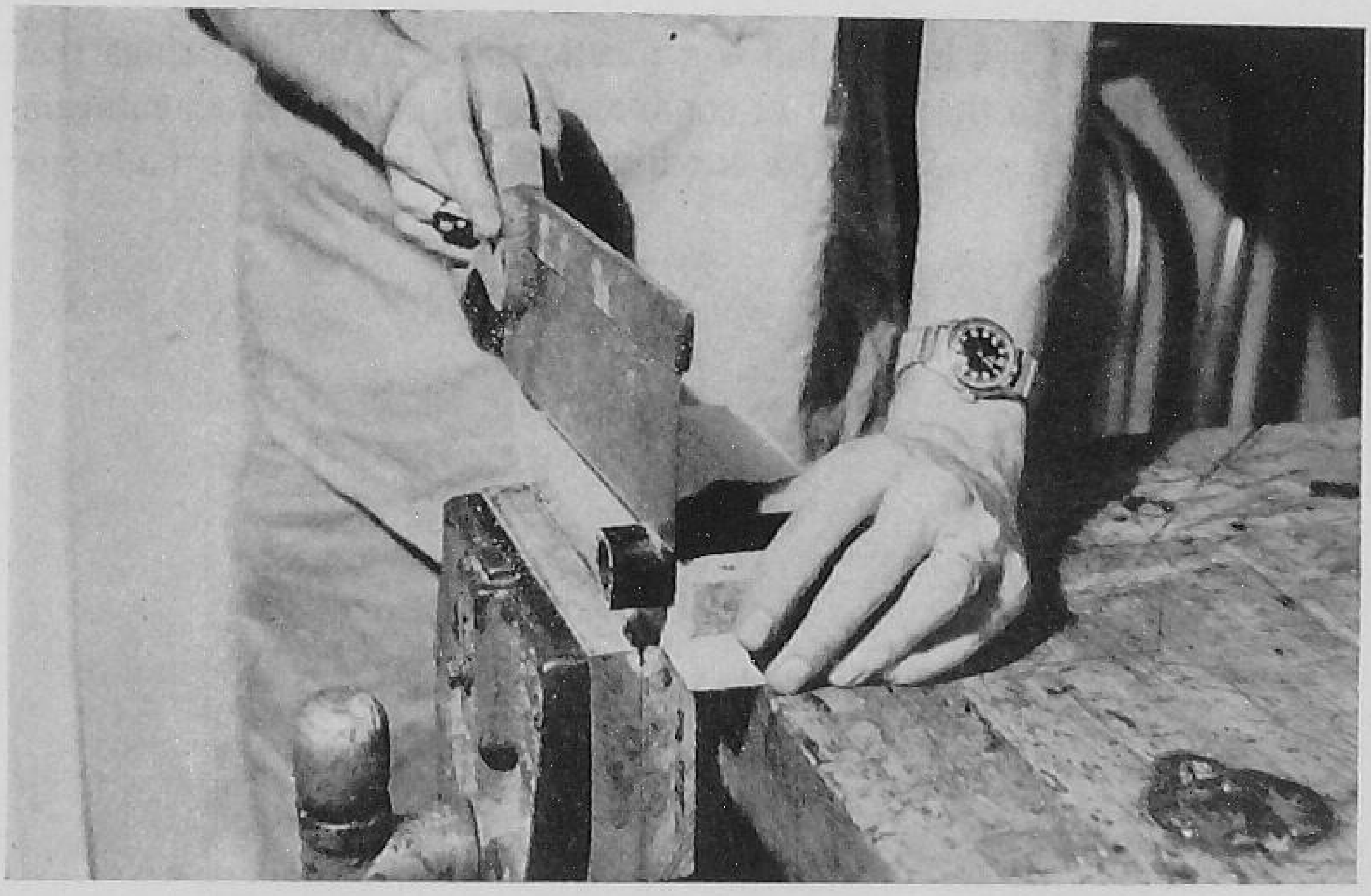


Fig. 26. Sawing with a back saw, using a bench hook.

or cracking, which would be present if the piece were held in a vise. Hold the piece securely against the bench hook support while sawing. The saw being used is a "backsaw." It is a fine-tooth crosscut saw (12 to 16 points per inch) with a thin blade, designed for particularly accurate work. It ranges from 8″ to 14″ in length and, as its name implies, its back edge is reinforced with a heavy rib of steel. Start the cut with a light pressure and continue through the piece with slow steady strokes. Make the cut at right angles to the length of the rod.

After the piece has been sawed to dimensions, the next step is to lay out the outline for the bottom section (Process No. 2). The block is held in the vise and marked out first with a pencil and then the lines are scribed into the plastic material with a scriber (Fig. 27). Next, the bottom section is

cut with a jeweler's saw (refer to Process No. 5 and Fig. 28). In this case the plastic block is held in the corner of the wood vise and the sections not needed are removed. Remember that the jeweler's saw should be used so that the cutting is done on the pull stroke rather than on the push stroke. Leave a little for the filing process. Do not obliterate or cut inside the lay-out lines. The ring is now ready for filing. In this case a combination of

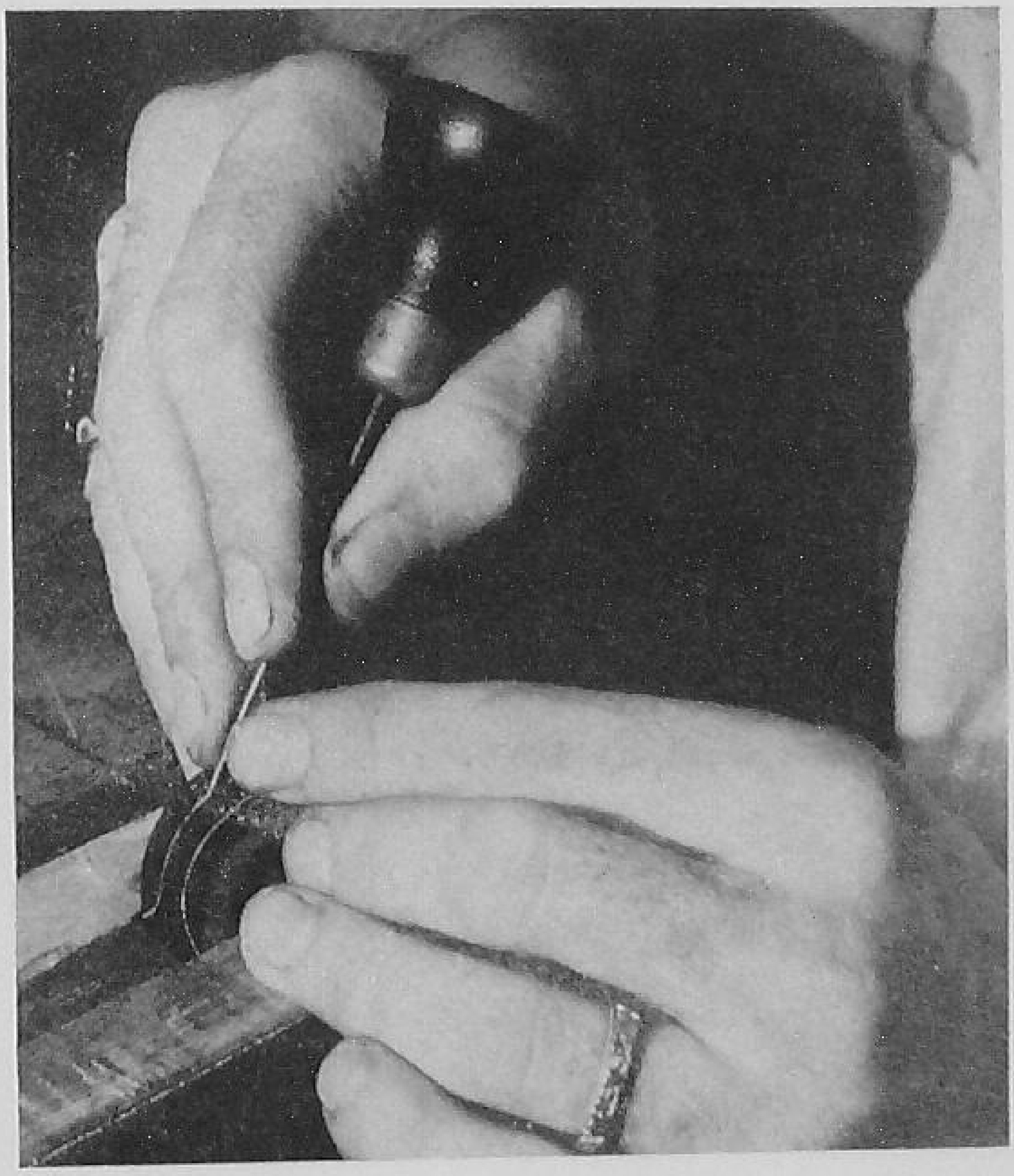


Fig. 27.

the hand type files (Process No. 4) and the jeweler's file (Process No. 5) will be necessary (see Fig. 29). File to the desired shape and round all edges. The ring is held in a ring clamp (Fig. 30). The ring clamp consists of two finger-shaped hardwood pieces tipped with leather inserts that are hinged in the middle section. A wooden wedge is forced between the fingers at one end to obtain the clamping action at the opposite end. Delicate pieces of material may thus be held while working on them with little danger of marring the surfaces.

The filed surfaces must then be thoroughly sanded (refer to Process No. 8). In sanding the inside portion, the sandpaper may be wrapped around a dowel rod of appropriate size.

The top section of the ring may be treated in a variety of ways. An initial or simple figure may be cut out of thin plastic sheet or rod and cemented to the top surface or the surface itself may be filed or otherwise

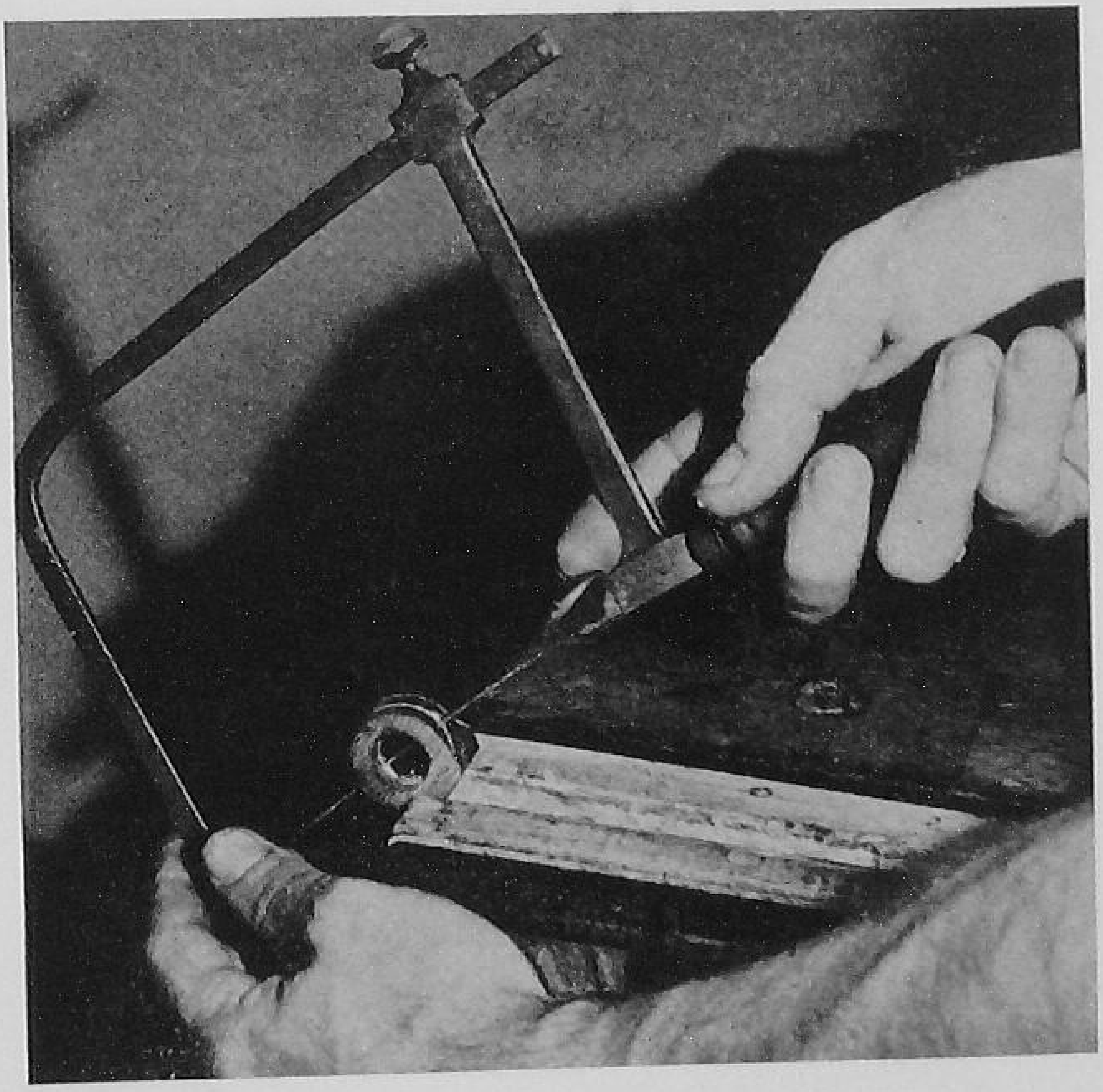


Fig. 28.

shaped to practically any desired form. The ring shown in Fig. 25 has a simple, circular, dome-shaped ornamentation. This piece was filed on the end of a rod, polished, and then cut off to the desired size. The method of cementing the ornament in place will follow. To hold the ring while buffing and polishing the outside portions, a piece of dowel rod which has been filed to a slight taper is utilized. The dowel rod chosen should be only slightly larger than the ring hole so that when the ring is pushed on the tapered portion, it will be held securely. Push the ring on to the tapered dowel

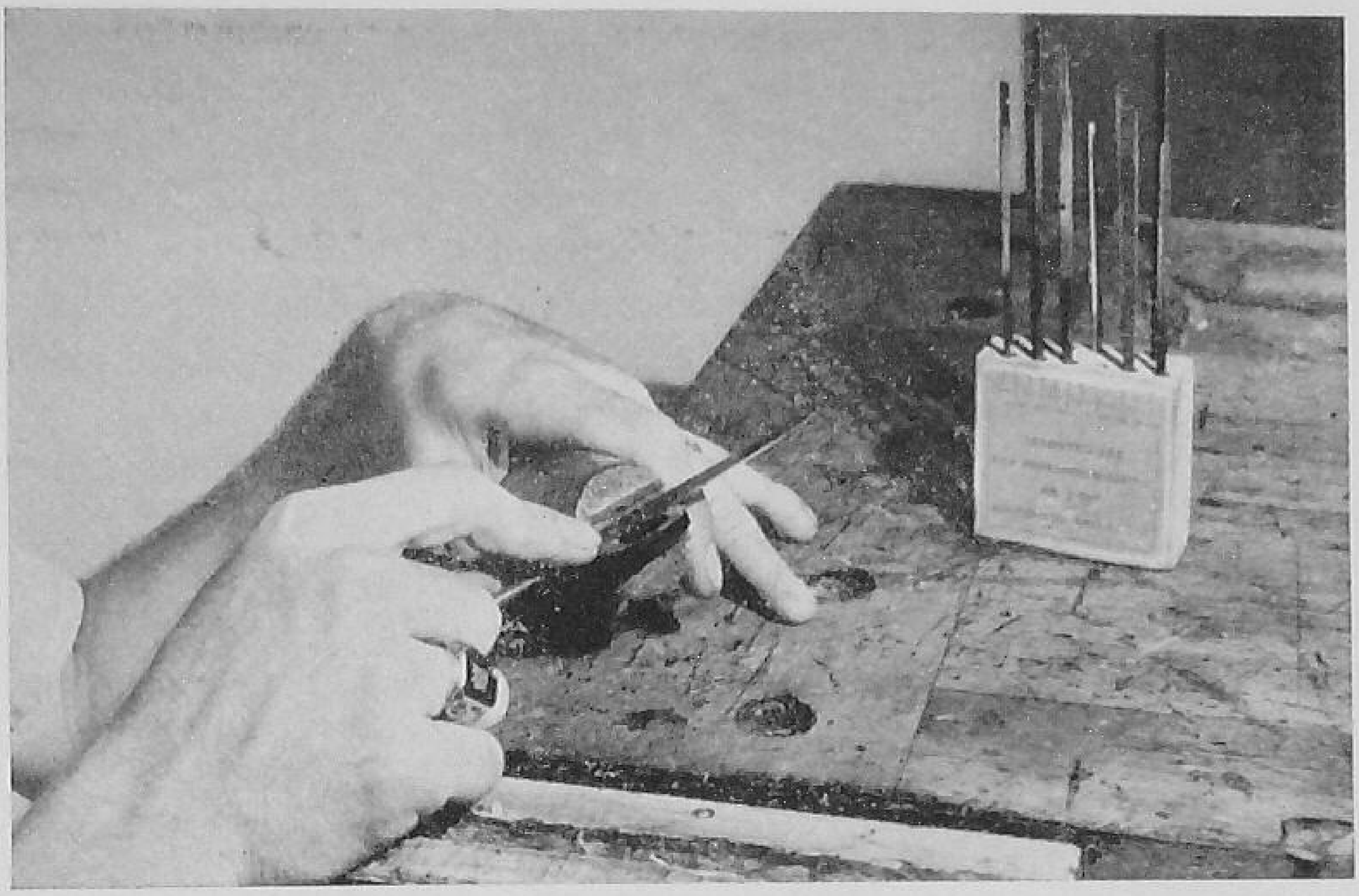


FIG. 29. Filing with jewelers files.

gently; otherwise the ring may be broken. The inside portion may be conveniently buffed with a conical type buff of correct size. Polish the entire ring with a soft buff or chamois.

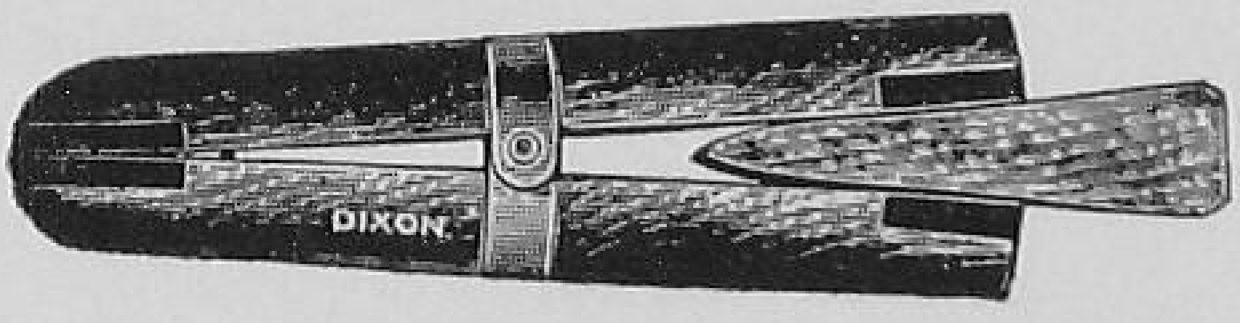


FIG. 30. Ring vise clamp. (*Courtesy William Dixon Co.*).

Process No. 12. Cementing

Cement the ornament you have chosen to the top of the ring. This process is very simple and most useful. In fact, the ease with which articles may be assembled by cementing is one of the fascinations of working with plastic materials. The joint produced in cementing should be, in general, just as strong as the material being cemented. If the process is done carefully, the joint is practically invisible, giving the impression that the article is a solid mass of carved or machined material.

There are several rules which, if followed, will more or less guarantee success.

1. *Prepare the surfaces being cemented so that they fit each other nicely.* This is important for two reasons. First, the joint will not look well if a large layer of cement is exposed; and second, the pieces will be likely to move during the cementing process and weaken the joint. The surfaces must be free from dust, dirt, grease, fingerprints, and water.

2. *Use the proper cement.* The cements fall basically into two groups—those that are merely solvents, and those that are made from the plastic resin itself. Most of the resin types require a catalyst or accelerator. It is advisable when ordering plastic material to order the particular cement developed for that particular plastic.

There is no one cement that will give good results for all plastic materials. The table below gives information concerning cements that may be used. There are many other cements sold under various trade names. The compositions of most commercial cements are trade secrets.

Plastic Material	*Cement*
1. Cast Phenolics	Catalin Co. Catabond 200 CZ with HCl accelerator Catalin Co. Catabond 700 with special accelerator
2. Acrylics—(Plexiglas or Lucite)	7 parts ethylene dichloride and 1 part plastic chips Duco cement—Plastiset—Chloroform—Acetone Acrylo Cement (Berton Plastic Inc.) Methylene Dichloride—Ethylene Dichloride—Acetic Acid
3. Cellulose Group	Shavings dissolved in either acetone or a mixture of ethylene dichloride and alcohol
4. The Vinyl Group	Often heat sealed with heated iron at about 350°-400° F. Most other common cements work well (test on scrap piece for correct action)
5. Polystyrene	Polystyrene shavings dissolved in suitable solvent like benzene, ethyl acetate, or ethylene chloride. To join to metal or other materials, use Thiokol, Glyptal, or Reanite type cements.

For the cast phenolics use Catalin's Catabond No. 200 CZ or Catabond No. 700. The No. 700 cement dries white and the No. 200 CZ dries transparent (with a slightly bluish cast). The correct cement to use is always

specified by the plastic manufacturer and may be obtained, together with directions for use, from most of the many craft supply houses. If the cement requires an accelerator, be sure to use the recommended proportions and to stir thoroughly. In general, the more acid (or accelerator) used, the quicker the cement sets. The cement should be kept in a cool storage place and be tightly corked to prevent evaporation. It is well to buy cement in small bottles as it very often deteriorates rapidly after the bottle has been opened. The cement resin should be mixed with the accelerator on a glass slab. Use the cement sparingly and be sure to wipe away any excess with the proper solvent (usually alcohol or acetone) after the joint has been pressed together. With a little practice one can gage the amount of cement needed so that little or none will squeeze out at the joint.

The bonding of two surfaces with the solvent type of cement depends basically upon the intermingling or fusing of the surfaces because of the action of the solvent. After the surfaces have sufficiently softened they must be joined quickly enough and with just enough pressure to exclude air bubbles and keep the surfaces from moving while the solvent evaporates. Small "C" clamps may be used to prevent slipping during the cementing process. It is good practice to mask the surrounding areas of a joint to confine the solvent to the desired areas. Scotch tape is often used. Sometimes the surfaces to be joined are "soaked" in the solvent to deepen the softening effect. Thirty to sixty seconds is sufficient for this effect in most cases.

3. *Hold the pieces stationary while the cement is setting.* This means that some sort of pin, dowel, or clamp must be used (Fig. 31). For cementing small pieces, it is usually sufficient to allow the piece to set in the correct position until the cement sets. The pins or dowels, when used, are only to maintain the correct position until the cement sets. It is important that the holes which are to contain the dowel be drilled in the correct locations so that the pieces will be held in exactly the right position. This part of the job is quite difficult for beginners but may be mastered with practice. In Fig. 31 piece "B" is held along side piece "A" and the holes are layed out at equal distances from the ends and in the center with respect to width.

One disadvantage of the doweled joint shows up when cementing transparent materials. The joint in this case is quite unsightly. Some craftsmen use a transparent dowel in an effort to improve the appearance of this type of joint. In general, it is far better to use a clamp or some sort of a jig

(holding device) to maintain the position of the pieces while the cement sets and thus eliminate the necessity for a dowel.

An interesting and useful process was developed during the war to friction weld the thermoplastics. This type of bonding is accomplished simply by rotating one piece on the other until sufficient heat is generated to produce localized melting. Then the motion is stopped and the pieces weld together. This may be done with rods in the drill press. The rod should

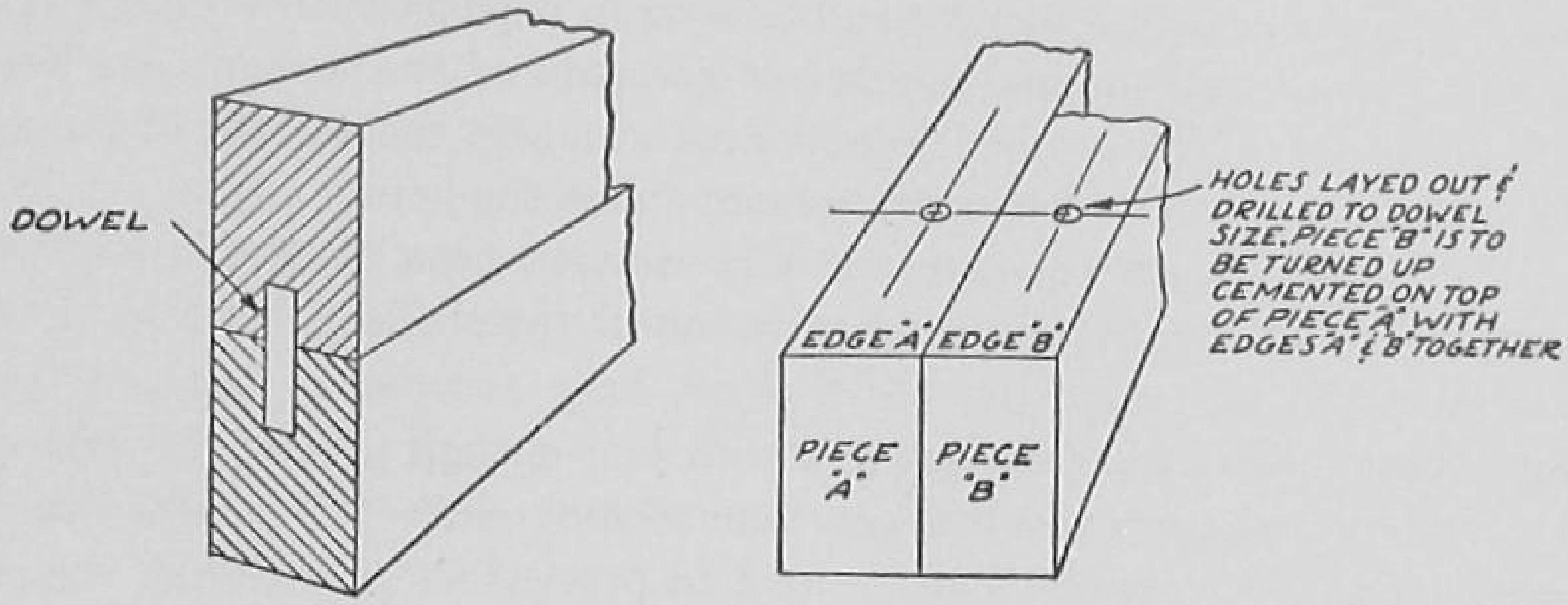


FIG. 31. Using dowels.

be turned at about 2000 r.p.m. (for a 1″ rod) until the material begins to flow or smoke at the weld line. The power is then cut off and a good pressure maintained until the weld solidifiies (about 30 seconds). This process has been used to bond the acrylics to wood, glass, metal or ceramics.

4. *Allow sufficient time for the cement to set.* The time varies from 2 to 24 hours, but in general it is good practice to allow the cement to set overnight.

Chapter VII

PLASTIC BRACELET

The third representative project is a simple bracelet with an engraved surface design. The size and design are optional and the type of ornamentation may be altered to suit the individual taste. In general, the length of a bracelet averages 6″. The material may be selected from any of the following plastic groups: The cast phenolics, cellulose plastics, or the acrylics. Bracelet blanks of various materials are readily available.

Procedure

Obtain a precut bracelet blank, or lay out and saw a suitable piece from sheet stock (Processes No. 2 and No. 3). A precut bracelet blank is usually 6″ x 1″. The correct bracelet length is conveniently determined by measuring the wrist circumference with a tape measure or cord and subtracting approximately ½″. File and sand the edges of the piece (Processes No. 6 and No. 7). Lay out and scribe the design into the top surface (Process No. 4). The next step is that of engraving the design lines into the surface. As shown in Fig. 32, the bracelet blank is fastened to a piece of wood by small nails. This is a great help in holding it, as the wood support may be clamped to the bench or held in a vise (Fig. 33).

Process No. 13. Engraving by Hand

This form of surface decoration is easy to do and requires only the most simple tools. The tools shown in Fig. 33 are linoleum cutters. Although these tools are not specifically designed for this purpose, they will serve for the beginner if he is careful and takes light cuts. The sharp angled veining tool is used first to deepen the scribed lines and the small "U" shaped tool to smooth and widen them. The cutters are mounted in small wooden handles and are pushed by hand or tapped slightly with a wooden mallet. After a little practice the correct angle of tipping the tools for most effective control in cutting will be found. It is good practice to cut a few lines in a scrap piece before beginning on the bracelet. If you do not have linoleum cutters, effective engraving tools may be made from 4″ or 6″

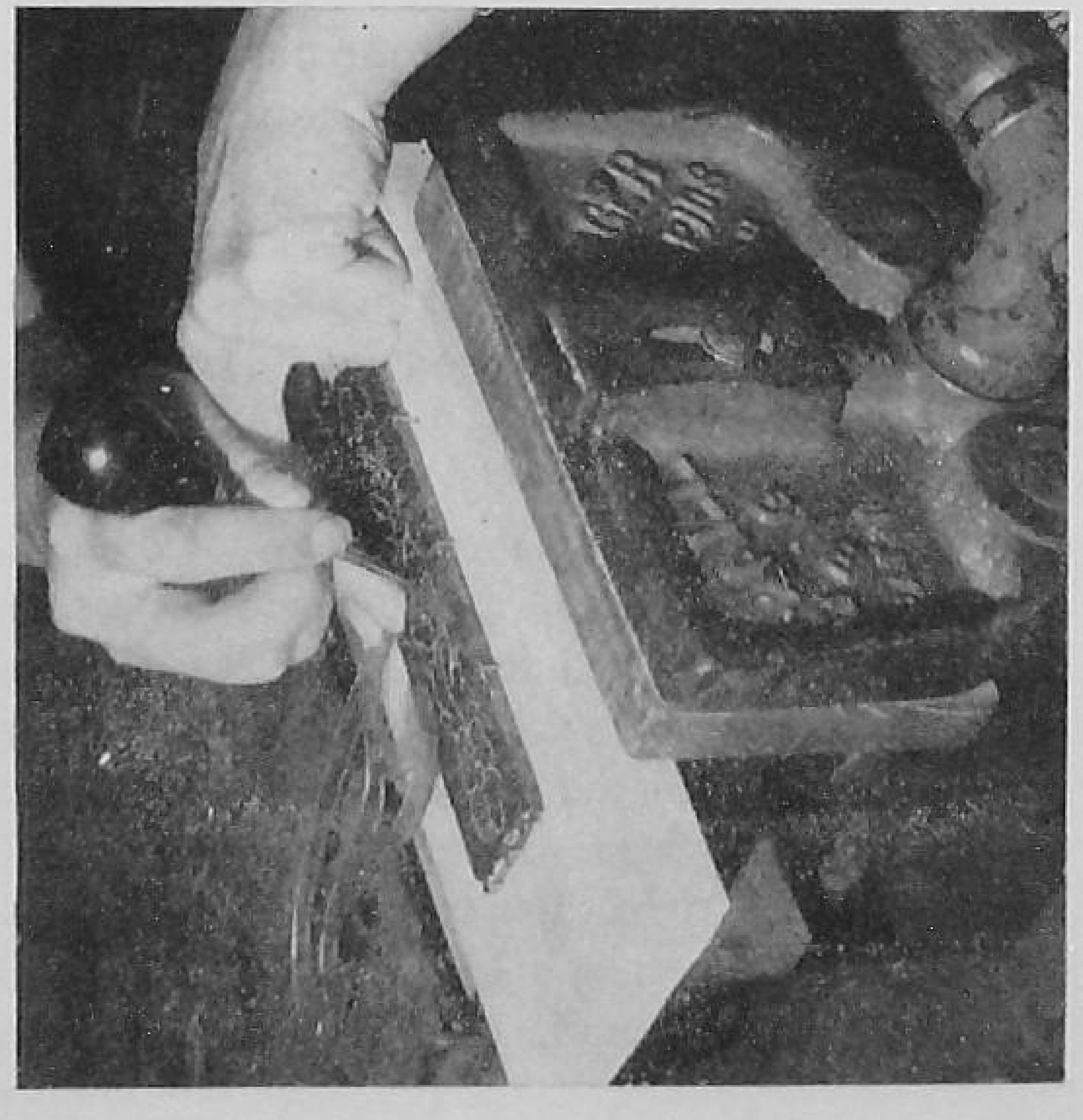


FIG. 32. Scribing in curved lines with the aid of a French curve.

FIG. 33. Engraving with linoleum block cutters.

three-cornered files. Merely grind the end to the desired shape with a point angle about like that in Fig. 34 and mount in a standard file handle. Engraving tools that are used for engraving metals may be readily obtained and will prove effective in plastic work if ground to the correct cutting point angles. These tools will not do an effective job unless they are very sharp. They should be ground and then whetted to keenness on a fine abrasive stone.

Engrave the design to the desired depth and width and remove the blank from the wood. It is now ready for bending.

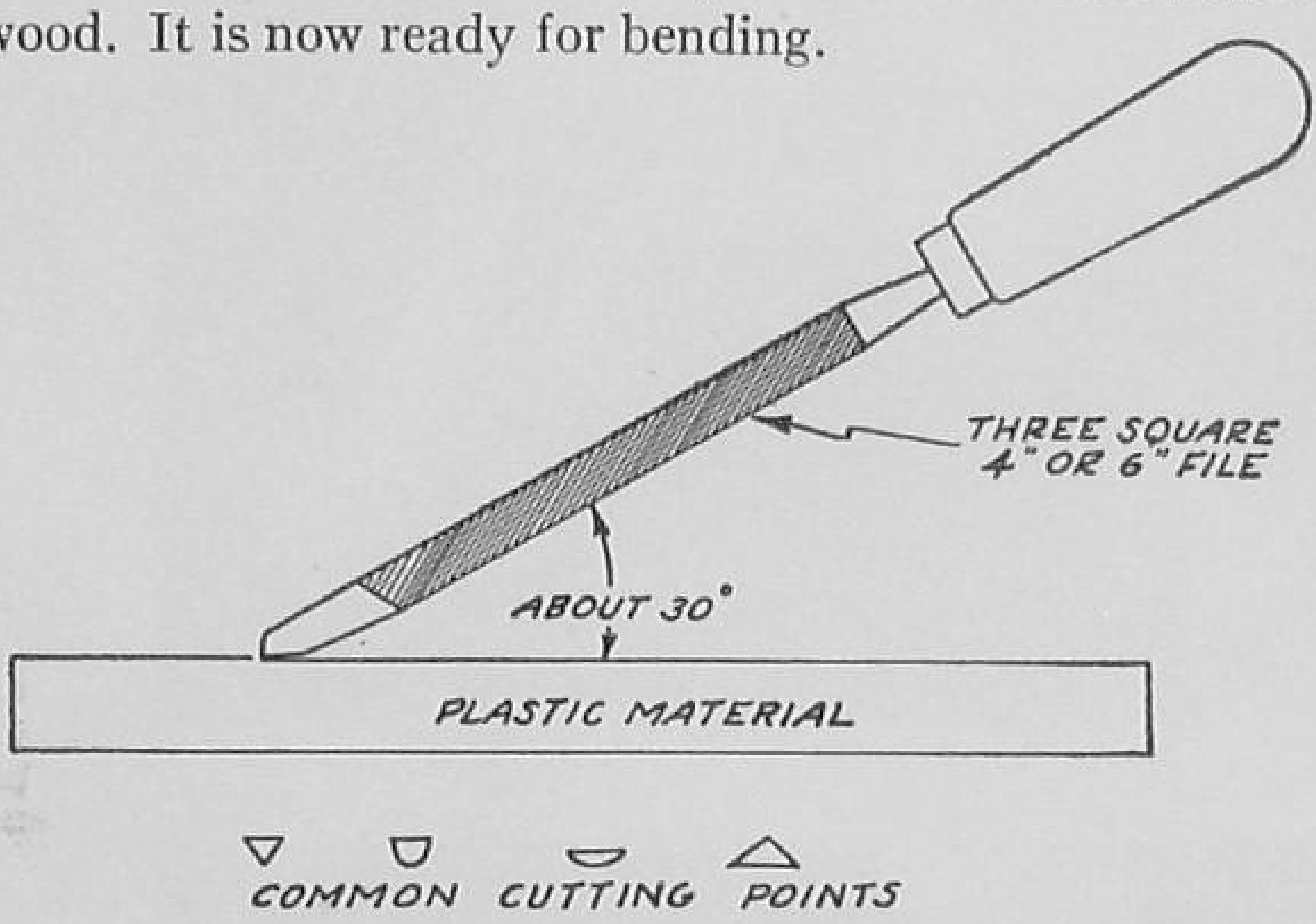


FIG. 34. Engraving tool made from file.

Process No. 14. Bending

The ease with which plastics (particularly the thermoplastic variety) can be formed by bending is one of the chief reasons for their great popularity. No other construction material can compare to them in this respect. Iron, wood, fiber, ceramics, etc., all may be formed by bending but the difficulties are great compared to those encountered with the plastic materials. Simple bends are often done by hand, but even the uncomplicated type turn out better if some sort of a supporting form or jig is prepared over which the bends are made. This is particularly important when two or more identical bends are to be made. The craft shop should be equipped with an assortment of these jigs for general use. A jig is a contrivance for holding in position the piece on which you are working. A jig convenient for use in bending bracelets in shown in Fig. 39. In this case, the jig is made of wood which has been sawed to the desired shape on the band saw. The heated bracelet is inserted into the slot provided so that one end is held securely while the bending is done. The bending is done on one end and

then the ends are reversed to obtain the desired form. The jig insures a uniform bend. The size may be altered by a slight bending after the bracelet is taken off the jig. The plastic material must be heated to the softening temperature at which time it may be easily formed. The softening temperatures for the various plastic groups are discussed in Chapter II. A jig used in commercial manufacturing is illustrated in Fig. 35.

A simple oven to heat plastic pieces of all types may be made from a 3 or 5 gallon can or pail. The can or pail is tipped over on the open end

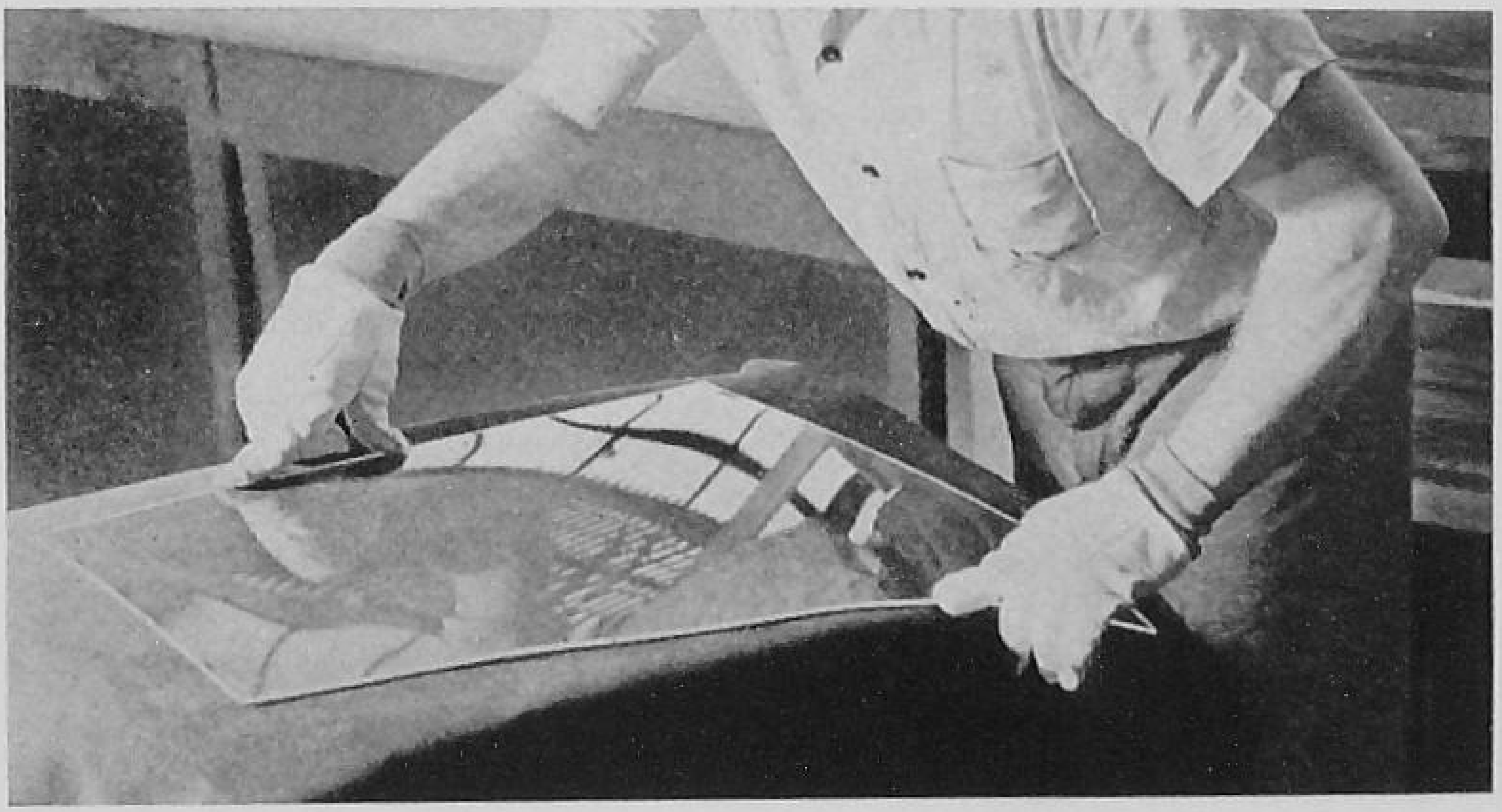


FIG. 35. Plexiglas is easily shaped by holding the hot piece against a suitable form until it cools. (*Courtesy Rohm & Haas Co.*).

and one or more electric lamps of adequate wattage are mounted in the top or sides. The one shown in Fig. 36 utilizes a 250-watt infrared heating lamp, but many variations of this heating unit are possible. The shelf should, preferably, be a circular piece of asbestos board mounted on a suitable support. Some experimentation as to lamp sizes and heating times for different types and sizes of plastic pieces will be necessary. By correct regulation of the heat several pieces may be kept in the correct working condition at once. By insulating the can (with asbestos sheet) both inside and outside, its effectiveness and ease of handling are greatly increased. The kitchen oven equipped with a thermostat will serve as an excellent heater for plastics. Be sure to use soft cotton gloves while handling the hot plastic pieces to avoid burns and also scarring of the polished surfaces.

The acrylics like Lucite and Plexiglas may be formed into simple dishes and bowls. The common method is to use a wooden ring and plug that have been machined to the desired size. The plug should be about ½″ smaller in diameter than the inside of the ring and the contours of each must be rounded and smooth. The plug may be fitted with a vertical handle so that it may be used to force a ¼″ heated sheet disk down through the ring. This action will result (after a little practice) in a scalloped edge dish or bowl. The scallops may be adjusted by hand after being formed by the plug and ring.

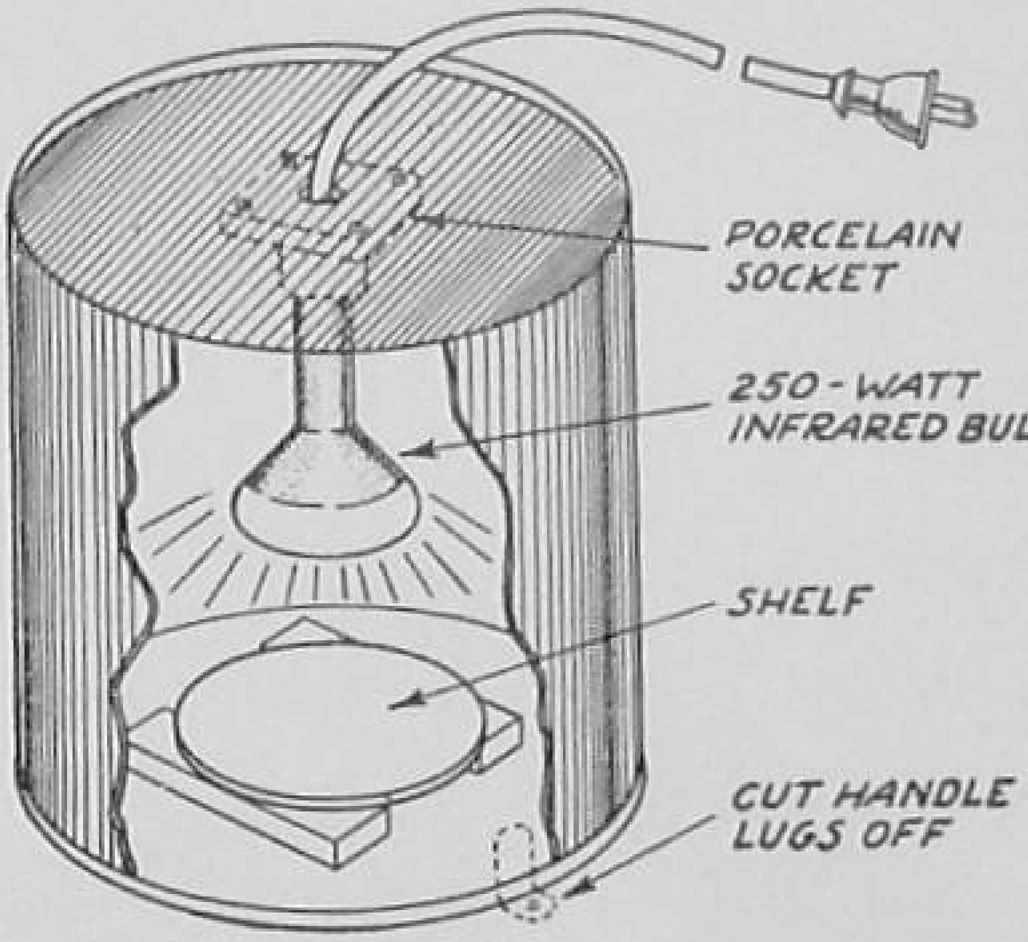


FIG. 36. Home-made plastic oven.

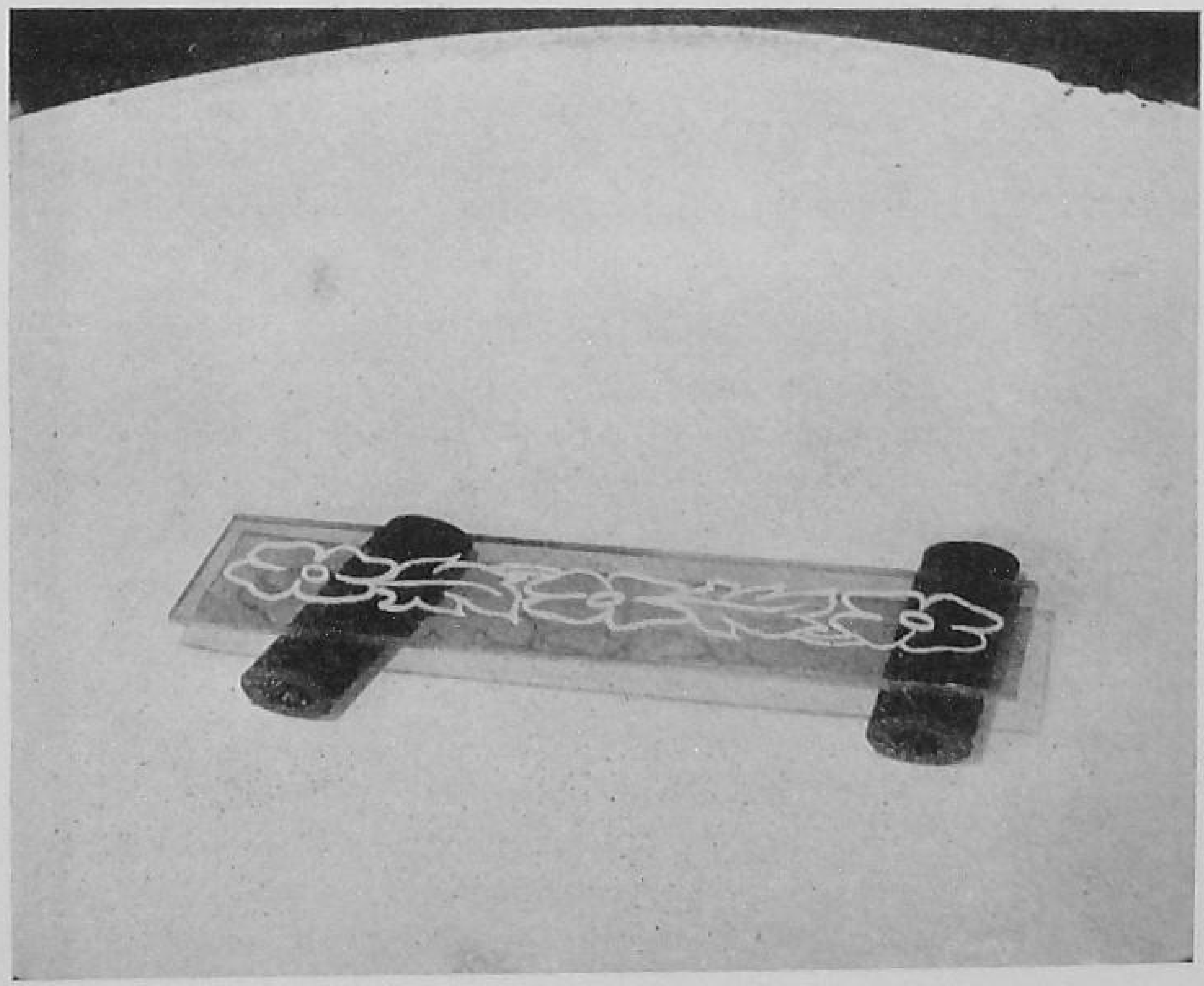


FIG. 37. Heating in hot water.

FIG. 38. Bending with the aid of a bending jig.

The method of bending the bracelet described here is used to good advantage when the softening temperature of the plastic material does not exceed 212° F. (the boiling point of water). Of course, various other

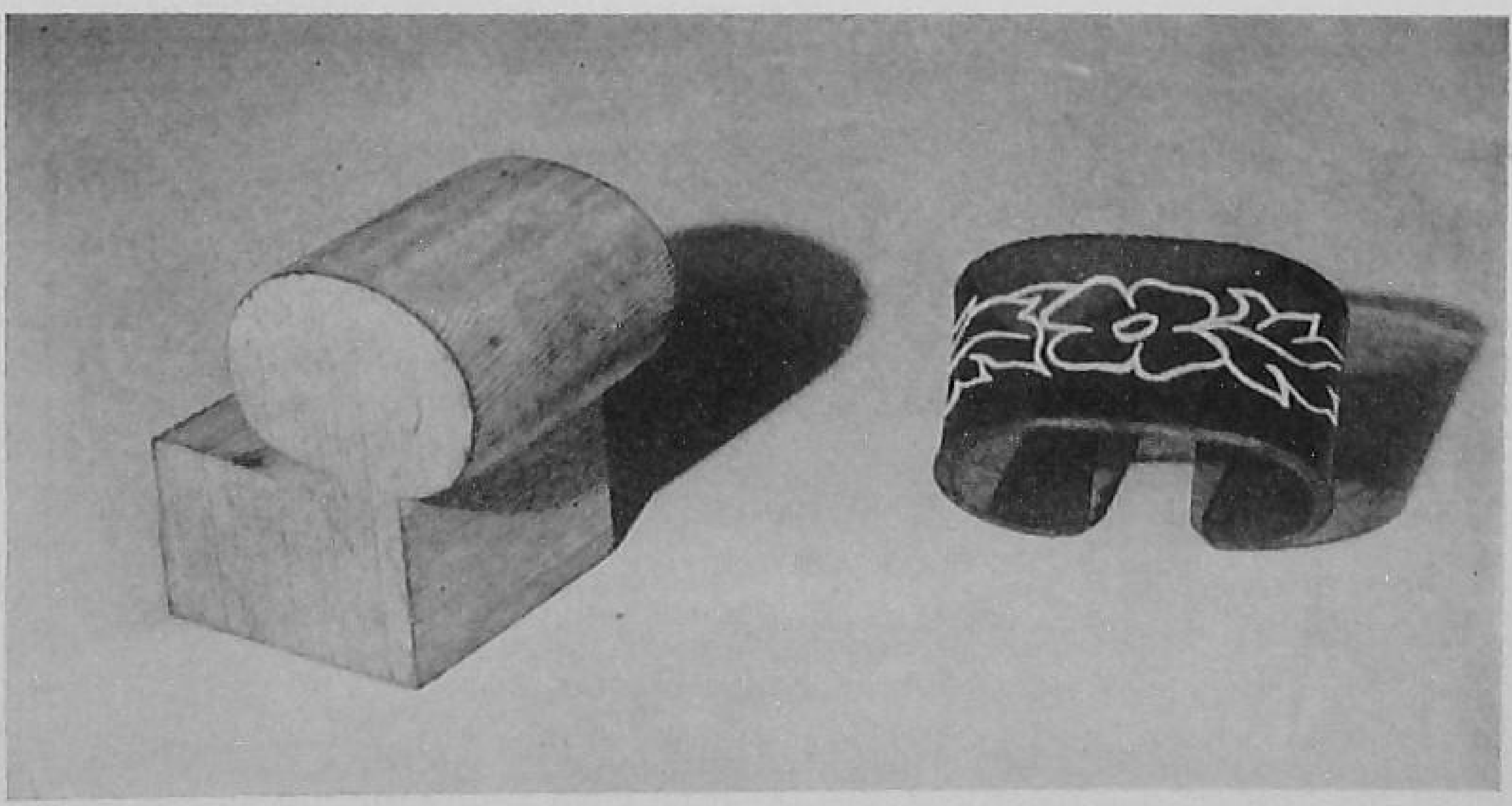


FIG. 39. Bending jig with bracelet which has been bent on it.

liquids such as oil or glycerin solutions could be used to obtain higher temperatures but they are dangerous and not recommended for the beginner. The bracelet is immersed in a dish of very hot water until soft. The softening usually takes about 3 minutes for each 1/8″ of thickness, and it is good practice to boil the water in a kettle on the stove and then turn it into another dish for use in the softening process. This prevents the plastic from possible harm if it touches the bottom of the kettle while heating. The bracelet in Fig. 37 is shown being supported on two bars of fiber so that it will not come into contact with the bottom of the pan while in the softened condition. Lift the piece out of the water by using a loop of cloth. Handle with soft cloth or soft gloves (Fig. 38). The bracelet may be returned to the water for further heating as many times as are necessary (except in the cast of the cast phenolics). Bend one end at a time on the jig. Cool the plastic in air or by allowing cold water to run over it. It will retain its shape indefinitely when cool (Fig. 39).

The bracelet is now ready for the buffing and polishing processes. (Processes No. 9 and No. 10.)

If one desires to obtain greater contrast between the polished surface and the engraved design, the lines may be filled with a coating of lacquer or paint. This is done by utilizing a small piece of waste or cloth with a small amount of the coloring substance on it and wiping across the bracelet. This leaves a small portion in the engraved lines. Then, immediately, wipe the surface clean with a soft cloth and allow it to dry. Be sure to get all the paint or lacquer off the polished surfaces. If the coloring agent is allowed to dry on the polished surfaces, the bracelet must be cleaned in the appropriate cleaner and the whole process repeated.

The bracelet may also be dyed if desired. The process is explained below.

Process No. 15. Dyeing

Lucite, Plexiglas, and many of the other plastics may be readily dyed with the cold dip variety dyes. These dyes, together with complete directions for their use, are available at most plastic supply firms. The piece to be dyed should be free from dirt, grease, and fingerprints. The container for the dye should be deep enough to insure complete immersion of the piece and should be made of glass, copper, stainless steel, or enamel. If two or more pieces are to be dyed at once be sure that they are not in contact with each other while in the dye.

It is always well to experiment with scrap pieces of the material being used.

The dye works by actually dissolving a small amount of the surface of the material, and the depth of surface penetration and the intensity of the color depend upon the immersion time. The plastic should be polished before dyeing. For pastel shades, 1 to 2 minutes is sufficient time. Deeper shades some times require from 2 to 5 minutes. The pieces should be removed and inspected to determine the correct shade. Wash in cool water and wipe dry with a soft cloth. The dye ordinarily can be removed from the hands with a chlorine bleach, such as "Zonite." Some of the dyes are inflammable and consequently must not be heated over an open flame. Most of them will work well at room temperature (about 70° F.).

Chapter VIII

PLASTIC POWDER BOX

The last of the four fundamental projects is a powder box. This simple project (Fig. 40) is typical of the many kinds of boxes and containers that are possible projects for the beginner. Here, again, practically any of the various plastic materials may be used. The phenolics are excellent for

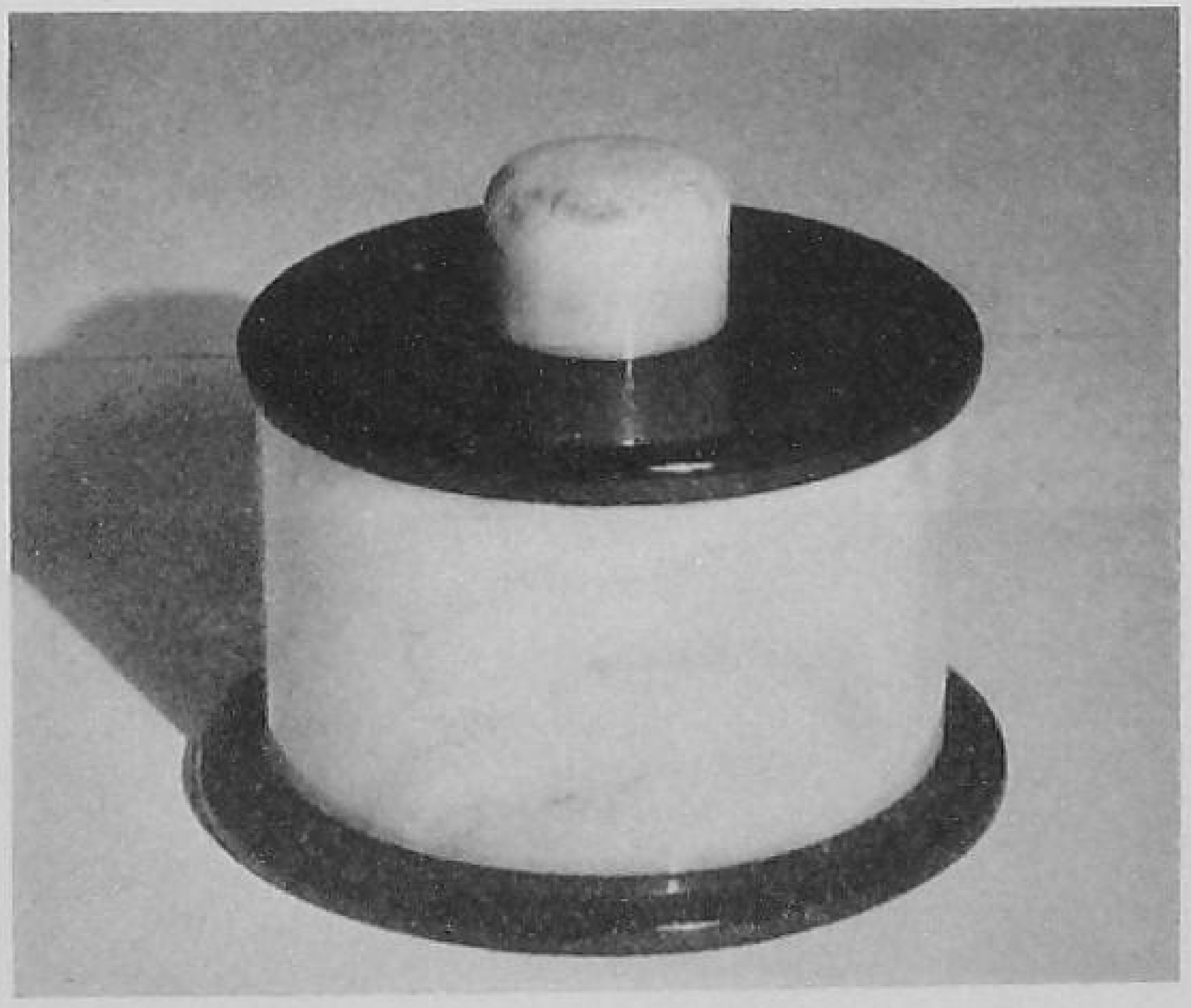


FIG. 40. Powder box.

this project. Refer to Chapter II for more information concerning materials.

Procedure

After deciding upon the materials to be used, design the box you wish to make. There are a variety of extruded shapes that should be considered, as well as the standard sheets, rods, and cylinders. As far as is feasible you should make a drawing or pattern for each separate piece of the assembly.

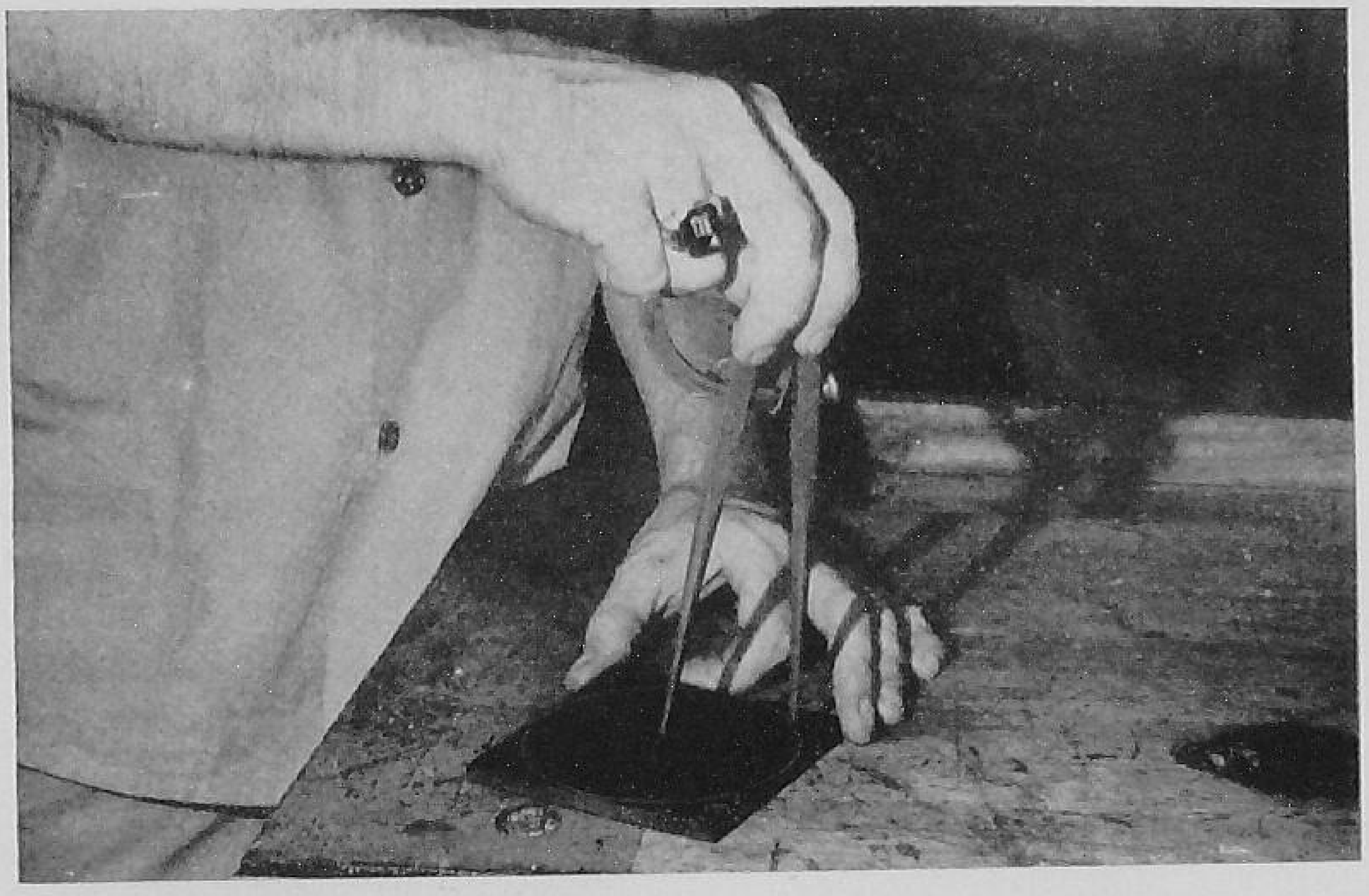


FIG. 41. Laying out circle with dividers.

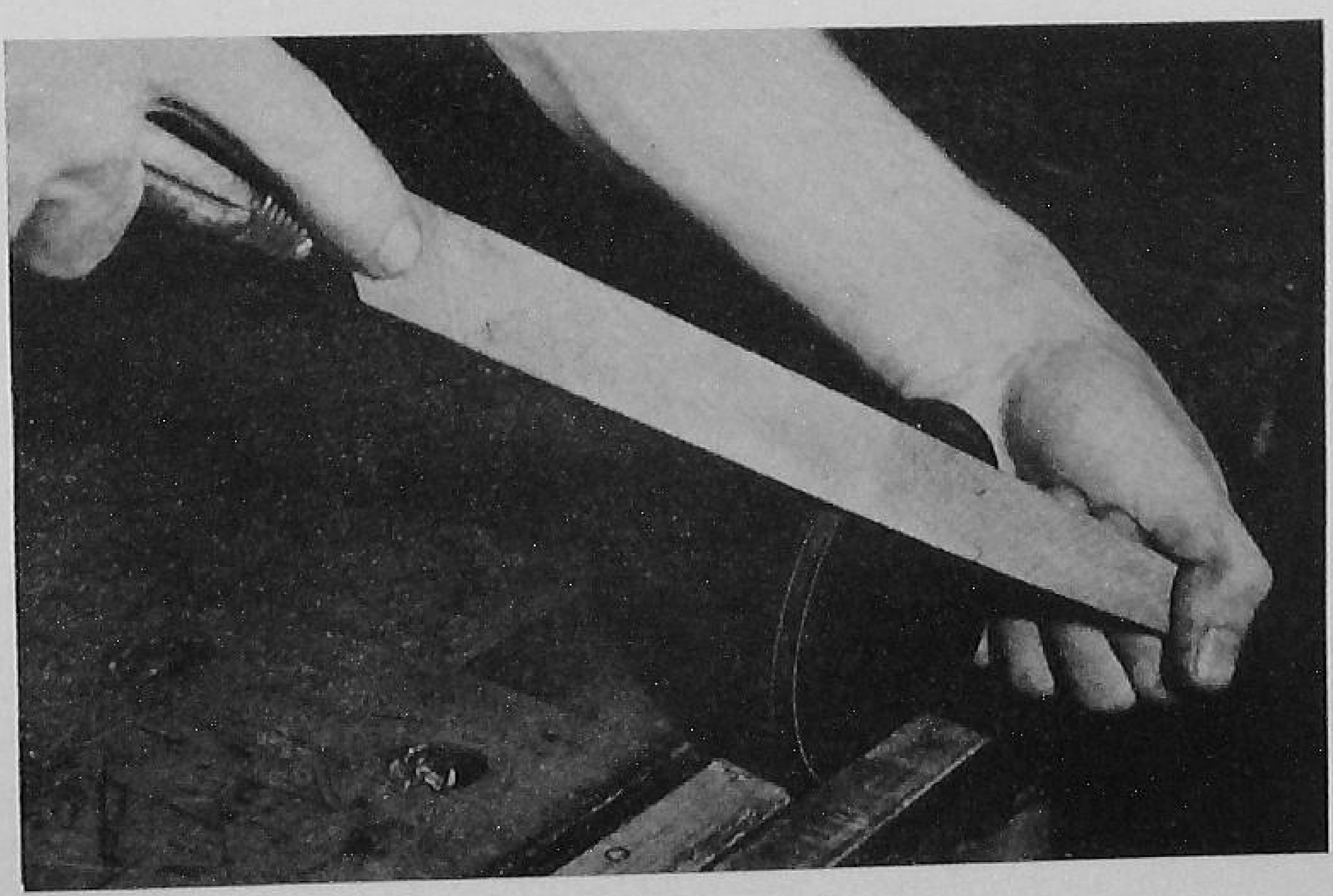


FIG. 42. Filing chamfer.

A freehand sketch of the assembled box is also desirable. The box illustrated consists of a bottom, a cylindrical body, and a circular cover with a knob or handle. A smaller circle of thin plastic sheet is cemented to the bottom of the cover to hold the cover in place.

Lay out the required circles by use of the dividers on the sheet stock. Then saw them on the band saw (see Process No. 5 and Process No. 25). File the edges to the divider lines (Process No. 6). Lay out chamfer lines with pencil or marking gage (Fig. 41) and file the chamfers (Fig. 42).

The edge of the cover may be either chamfered or rounded as desired. The bottom piece for the cover is finished with flat edges.

Process No. 16. Sawing with the Miter Saw

This saw is a large backsaw provided with an appropriate table and an adjustable supporting frame for ease and accuracy in operation (Fig. 43).

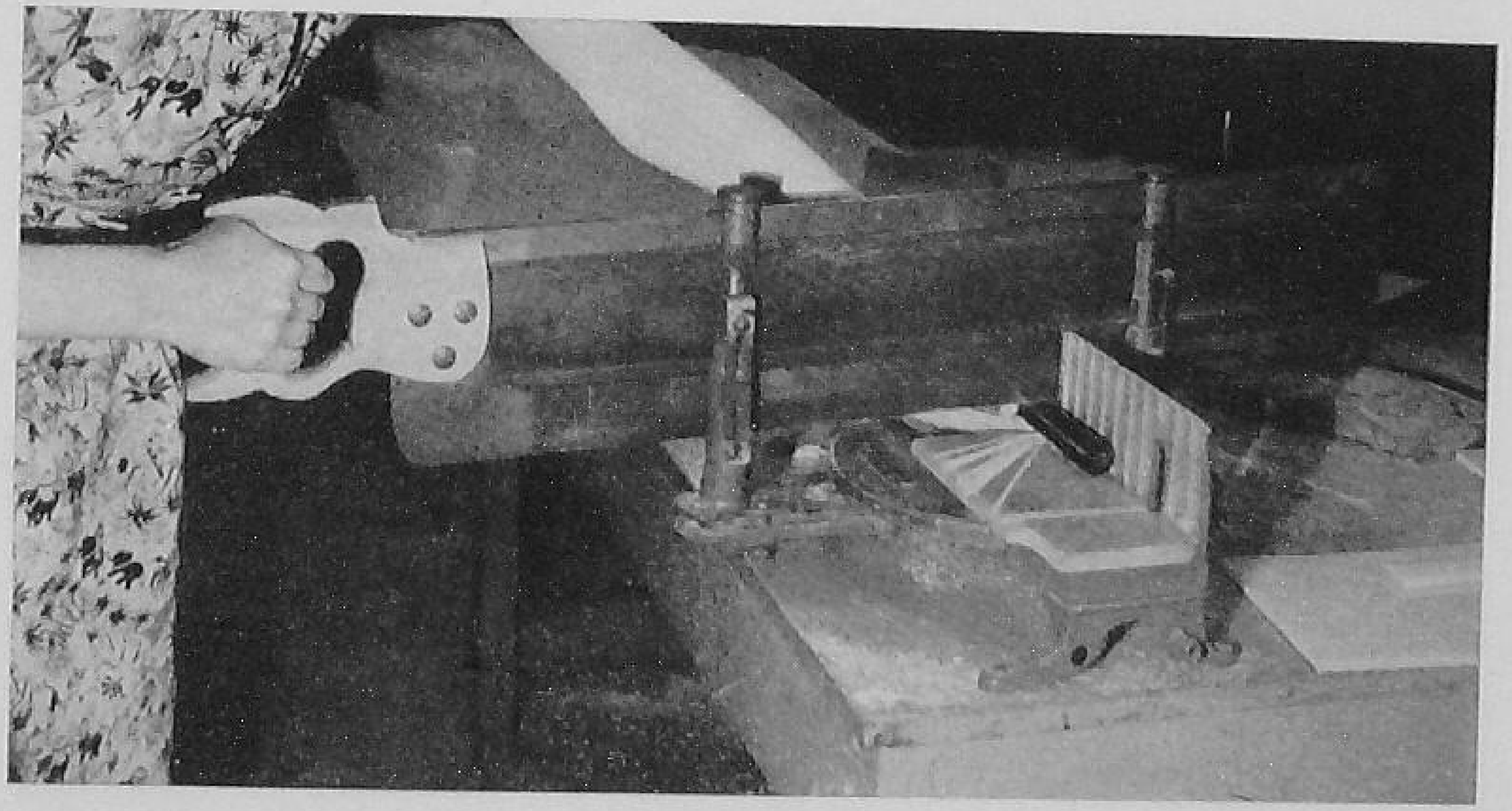


FIG. 43. Sawing with miter saw.

The frame of the miter box holds the saw rigidly in a vertical position, but it can be adjusted so that the stock can be cut at an angle. The rod or cylinder is held on the table against the back support, the saw is brought down to the rod carefully and the rod sawed with steady, easy strokes. The pressure exerted by the weight of the saw is sufficient to make the saw cut.

The knob and cylinder for the powder box is sawed off with this saw.

The rod chosen for a knob should be turned or filed to the desired shape at one end before being cut off. Many knob shapes may be made readily by hand. Shapes bounded by flat surfaces may be filed. The knob in Fig. 40 could be made by the much more easy method of "turning" in a wood or metal lathe (Processes No. 31 and No. 32). The knob is doweled and cemented to the cover (Fig. 31). The holes for the dowels are laid out at the exact center of the top of the cover and the bottom of the knob (refer to Process No. 2).

Process No. 17. Drilling with a Hand Drill

A hand drill is a drilling instrument fitted with a chuck to hold steel twist drills. The rotation necessary for drilling is obtained by turning a

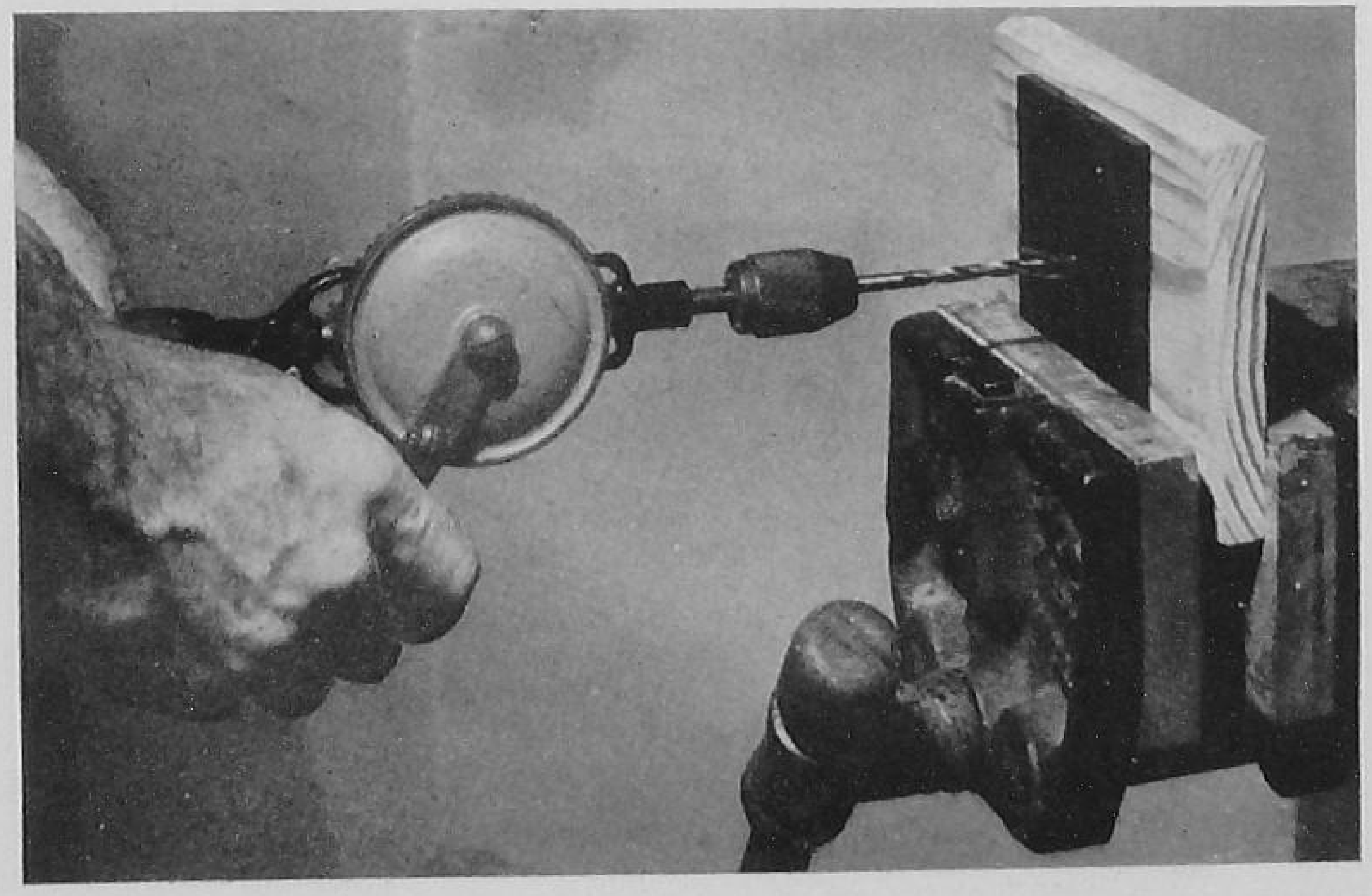


FIG. 44. Drilling with hand drill.

handle which is geared to the chuck spindle. The drills used are the common variety of carbon steel drills which may be bought singly or in sets. The proper size drill is inserted between the chuck jaws and clamped into place by turning the chuck body while holding the handle from turning. This causes the jaws to close and hold the drill in the proper position of concentricity. For small holes up to ¼″, the drills may be used as bought provided care is taken not to exert too much pressure while drilling. For the larger sizes a specially ground shape for the cutting edges is advisable.

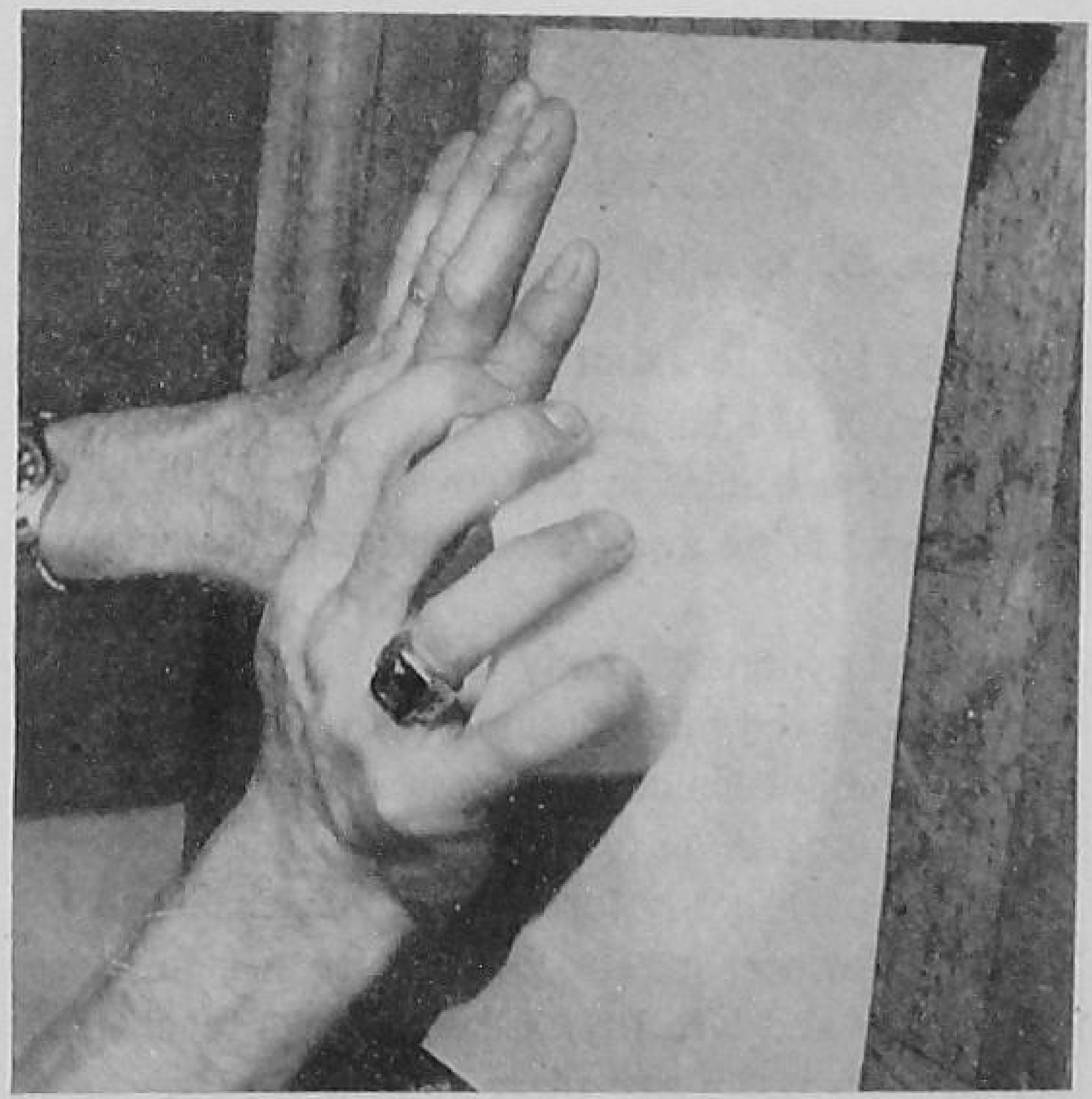


FIG. 45. Sanding cylindrical body.

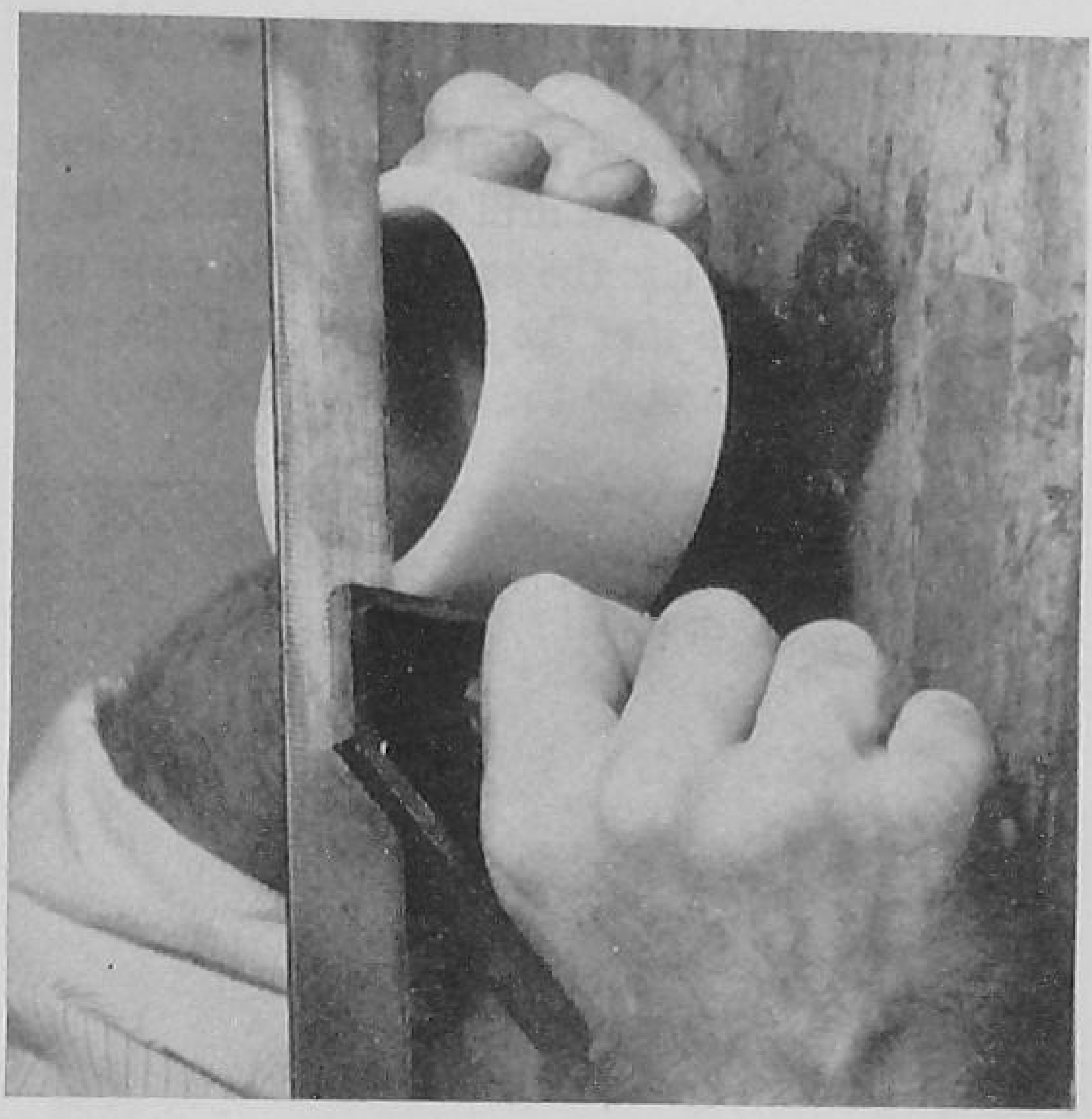


FIG. 46. Testing for trueness with a combination square.

A countersink or a larger sized drill may be used to bevel off the rough edges of the drilled holes.

For this doweling job, pick out a small plastic or wooden dowel rod about $\frac{3}{16}$″ in diameter and obtain a drill that will make the proper size hole for the dowel you choose. Use the scratch awl to open up the center holes that have been laid out so that the drill point will be easily led into them. Drill a hole (Fig. 44) through the center of the cover and also one

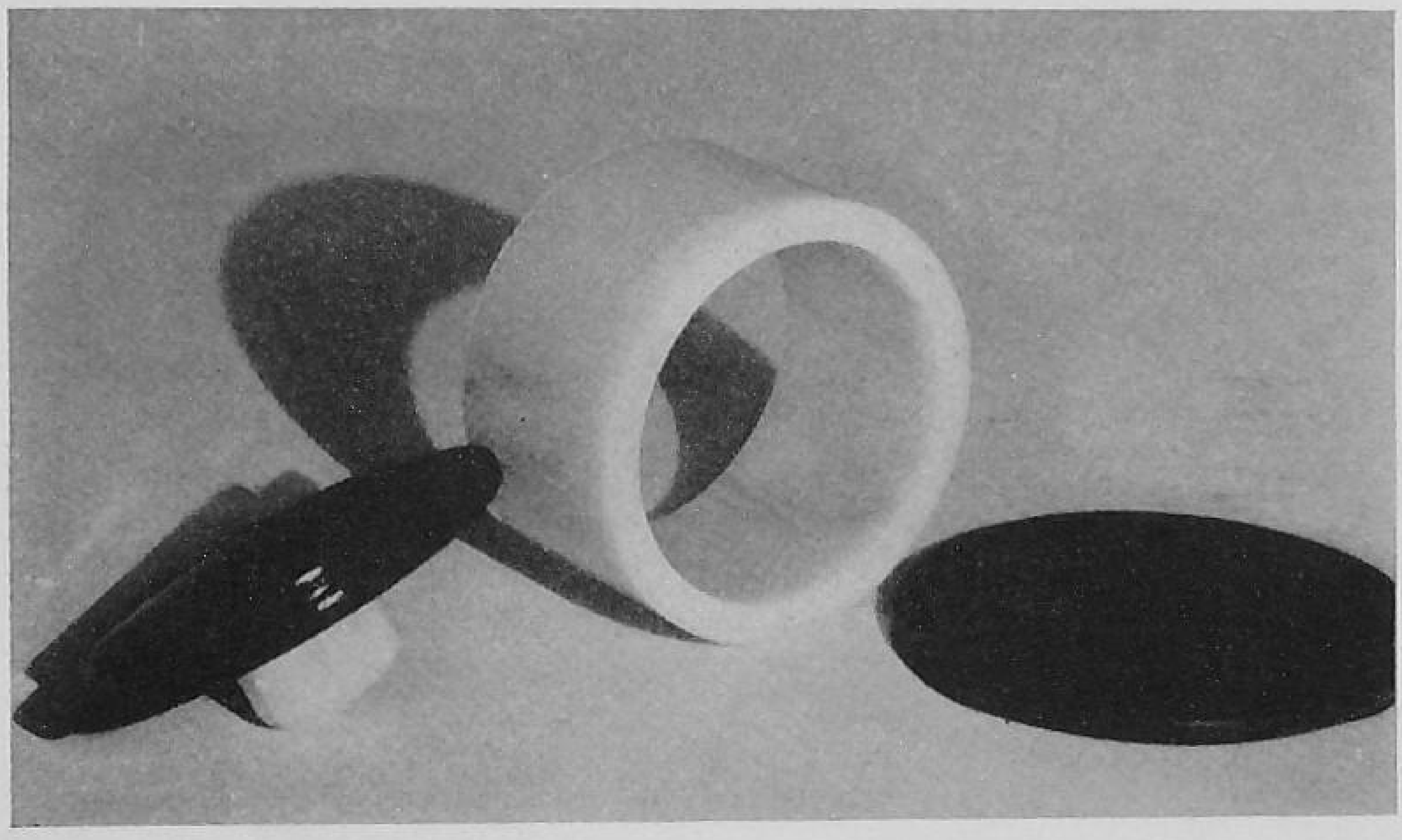


FIG. 47. Assembly parts for powder box.

into the bottom of the knob to about $\frac{1}{2}$″ depth. Use a dowel about $\frac{5}{8}$″ long. Sand the bottom of the knob to a smooth surface before cementing. Apply cement to the dowel holes in the cover and knob. Assemble parts and hold with a clamp. Wipe away excess cement (refer to Process No. 12).

Sand the edges of the cylindrical body true and smooth as shown in Fig. 45. Test for trueness with the combination square (Fig. 46). The top edge is to be polished and the bottom edge is sanded with fine sandpaper. Sand all parts in preparation for buffing (Process No. 8).

Figure 47 shows the parts ready for buffing and polishing.

Buff and polish all surfaces except those which are to be cemented together (Processes No. 9 and No. 10). Cement parts together (see Process No. 12) and set aside in warm dry place to set. Be sure to wipe off any excess cement.

Chapter IX

SOME ADVANCED TECHNIQUES

Process No. 18. Carving with Power Hand Tools

Carving is one of the most fascinating of the forming processes. It may be done with hand tools but much more easily and efficiently with one of the so-called "electric hand grinders." These tools are essentially a power

FIG. 48. Close-up of cutter or "burr."

driven chuck into which the various cutting or grinding tips are clamped. The cutters (or burrs) rotate very fast and only a light pressure is necessary for the cutting action. Be sure to try out the various cutting, grinding, and finishing accessories on scrap pieces of plastic material to see how they act. A little practice will help in maintaining the correct pressure and in determining the desired carved form. In general, the use of this tool is not dangerous because the cutting edges are blunt and will not cut the

fingers unless considerable pressure is used. Many different jobs may be done, such as cutting, engraving, sanding, grinding, buffing, polishing, etc. Setups for various special jobs may be made by holding the piece to be carved in a movable jig. In this case, the grinding tool is usually held stationary while the jig is moved or rotated as desired.

Fig. 48 shows a close-up of the tool with a steel burr held in the chuck. Fig. 49 shows this tool being used to even off the engraved lines on a paper knife. In addition to the rotary type carving tools, there are others that

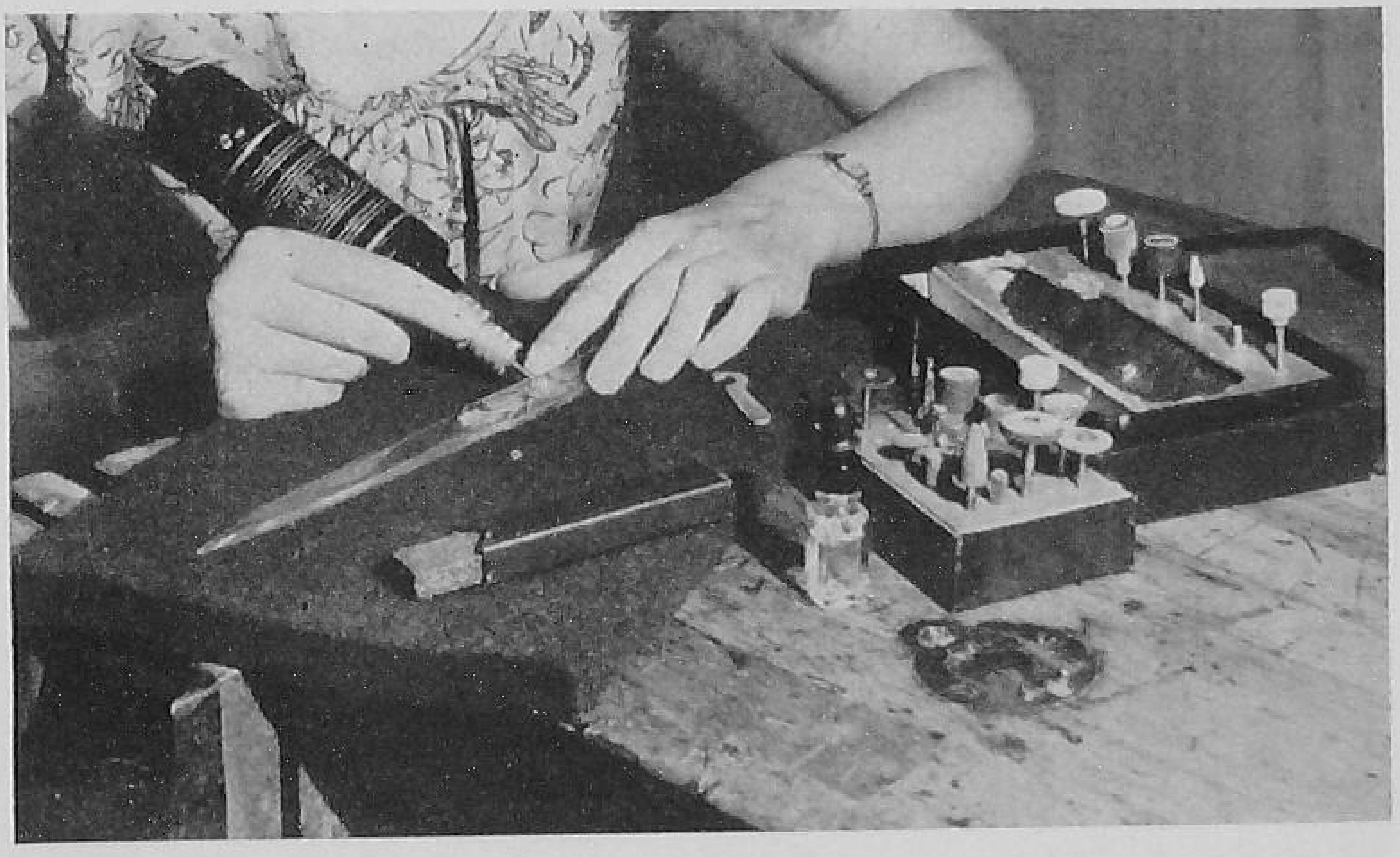


FIG. 49. Smoothing the engraved lines.

operate with a different cutting motion. Typical of these is the one shown in Fig. 50. It is known by the trade name of "Vibra Tool." Its cutting motion is obtained by the strong vibration of the cutter arm. A chuck is attached to the end of the vibrating arm and accommodates different shaped cutters for various jobs.

Perhaps the most striking and beautiful effects in the realm of craft work can be attained by a process known as "interior carving." This technique was advanced due to the great transparency and brilliance of the acrylics, Plexiglas and Lucite. Decorations that are carved into the reverse side of a block and viewed from the front attain a startlingly beautiful and lifelike appearance. The three-dimensional effect and coloring of such a carving are greatly accentuated. This comparatively new technique offers

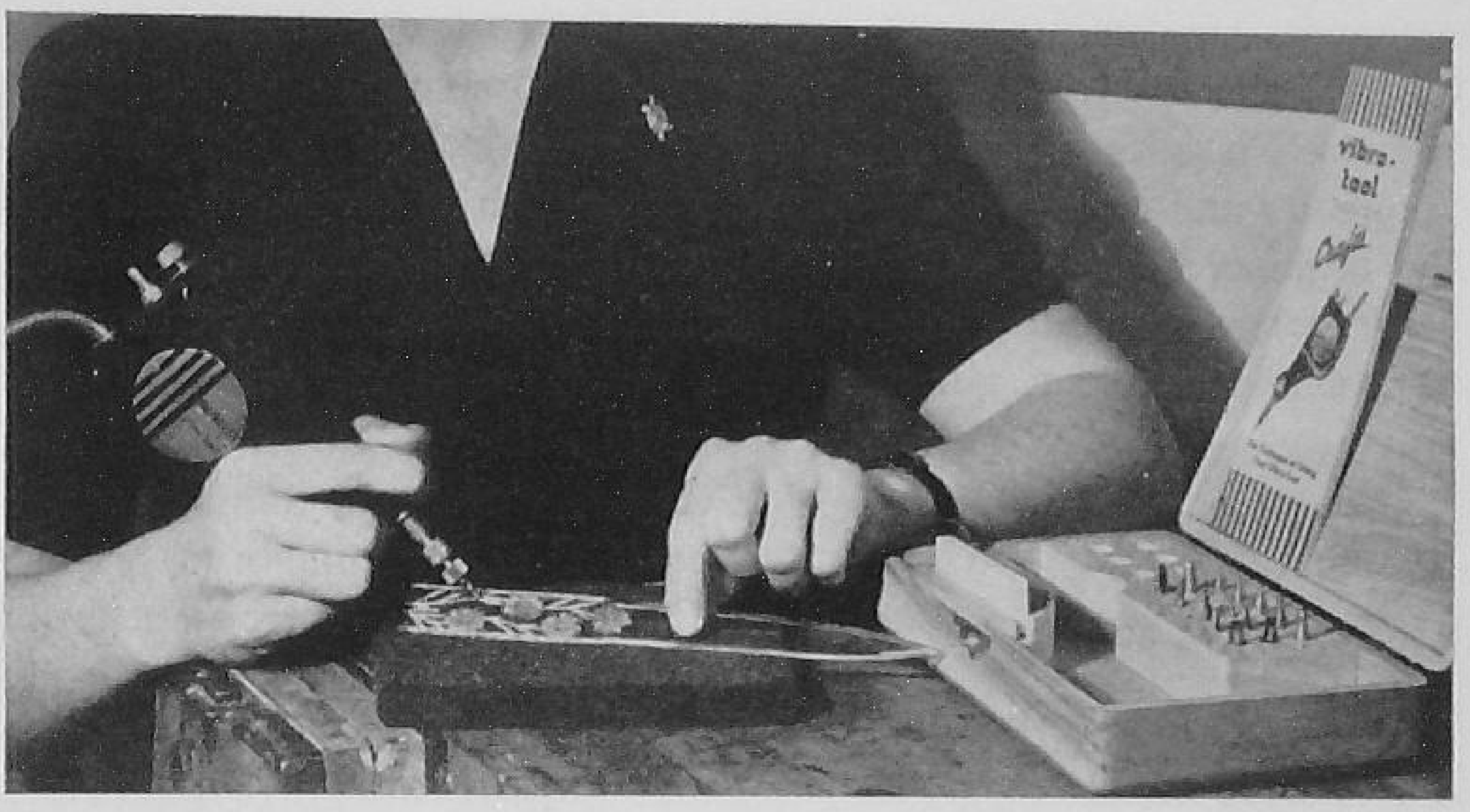


FIG. 50. Hand power tool (Vibro-tool).

the plastic craftsman a new medium of expression never before attainable in such a simple and unprofessional manner.

The carving is done with the regular cutters and burrs in the hand-

FIG. 50A. Interior carving.

motor kit, supplemented with a few specially ground pointed drills (Fig. 50B). These special drills are now available from many plastic jobbers. Any size Plexiglas or Lucite block may be used. The thicker the block the greater and more startling is the accentuation of the detail and color. The beginner should experiment with a small and inexpensive piece of plastic before attempting a large project. The technique is comparatively easy to master and a fair amount of practice will produce worthwhile results. Leaves, flowers, fish, landscapes, vines, and animals can be made after a minimum of practice.

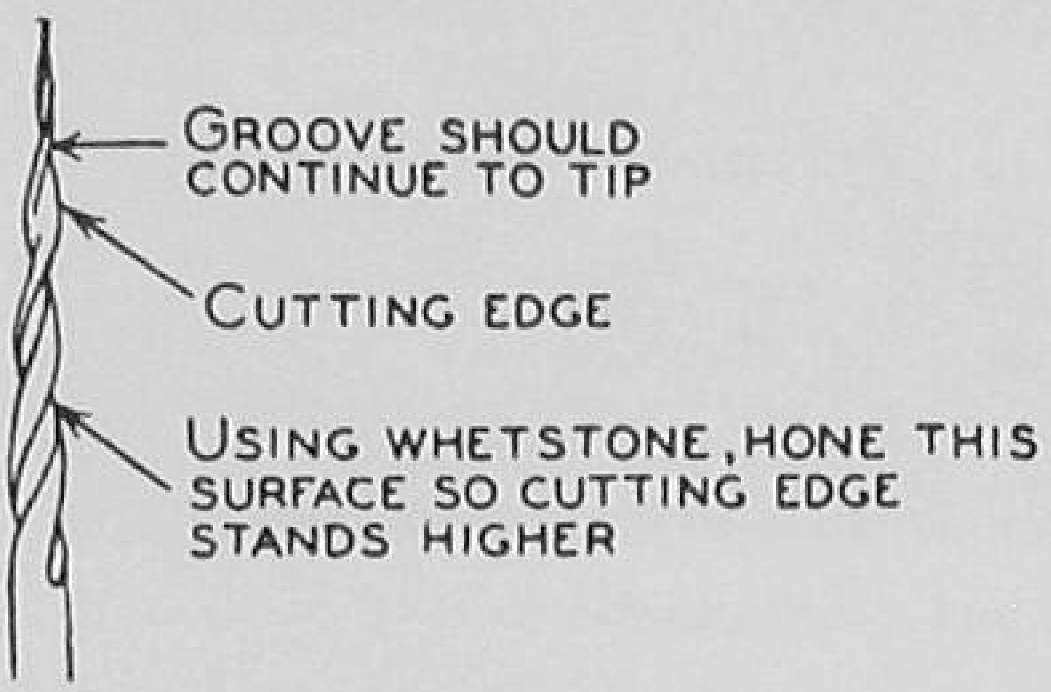


FIG. 50B. Interior carving tool. (*Courtesy Rohm & Haas Co.*).

A hand-motor tool with a flexible shaft is easier to use because it provides greater flexibility of motion and is easier to grip. The kit of tools should include at least one of the fine tapered drills, a standard set of drill points, cutters, and burrs, an eye dropper, and a scriber. The materials necessary are blocks of Plexiglas or Lucite, various colored dyes, water and oil paints, and plaster of Paris.

The procedure is as follows:

1. Practice making sample cuts on a discarded block. Hold the block in the left hand with the bottom surface exposed. The drill chuck is held in the right hand under the block so that the drill point may be pushed into the underside. If you wish, the left hand may be supported on a bench or one corner of the block may rest on a suitable support. As an aid in tool control, rest the thumb of the right hand against the bottom of the block. Practice making straight up and down "cuts" and then, after the tool is in the block, try moving the block cautiously to one side to expand the hole for various effects. Do not try to penetrate too deeply at first and use a variety of different points until you know just what to expect from each type. You will notice that the finer points are easier to control. Also when you start a hole, the drill point has a tendency to slip around on the polished surface. To overcome this last tendency the point should approach the surface in a line exactly perpendicular to the surface until the hole is started. Remember, depth is accomplished by moving the drill point, while the cavity is expanded in width by moving the block sideways or at an angle. Practice until you can remove material

from the cavity where you desire. Never allow the drill point to penetrate the top surface of the block.

The carving process must never be hurried. A firm, light, controlled pressure is necessary. Too much pressure will cause burning of the plastic or will bind the drill and cause it to lose its temper or break. The fine points, in particular, must be watched closely to prevent heating. Cut only a little at a time, giving the drill time to cool off. As in the process of drilling the point should be removed repeatedly from the hole to help in removing the chips.

2. After you are satisfied that you can handle the tools correctly, the next step is to choose a plastic block and a suitable design to fit it. For your first project use a small block and a simple design such as a flower with few petals. Draw the design on a sheet of paper and place the block on it. Imagine what the flower would look like if it were a three-dimensional object embedded in the block. Trace the design lightly with a wax pencil on the top surface of the block and then you are ready to start the carving process. Start by making the central cavity for the stem and then adding the petals from the central stem. The petals are accomplished by inserting the drill at an angle from the central stem and moving the block in an angular, circular motion. From now on you are on your own. This is what makes this technique so fascinating. Don't hesitate to experiment. Part of the background design may be cut into the bottom surface with a scriber or carving tool. Notice how little change in depth of cut is needed to make a very perceptible difference in the three-dimensional effect. The delicate parts of the design are done with the pointed drill.

3. After you have finished carving the design, the next step is to experiment with coloring. Here again experience is needed and so experimentation is in order. Many types of coloring are possible and many different coloring mediums are available. Plastic dyes, spirit stains, poster colors, oil and water paints, leather dyes, and powdered colors all may be used. The effect obtained depends upon the originality and experience of the craftsman. One of the dyes in common use is an analine acetone dye. It can be made by dissolving 0.5 gram of analine dye in about 180 cubic centimeters of acetone (or ethylene dichloride) and then adding 120 cubic centimeters of water. These dyes work best when fresh. They actually dissolve a little of the surface plastic and leave the color. Consequently it is not necessary to leave the dye in contact with the plastic for long. The dye is dropped into the cavity where the color is desired with an eye

dropper or hypodermic needle. Even a toothpick may be used. Use only a small quantity of dye and remove any excess with a "twist" of blotting paper. In the more intricate designs where many different colors are to be used, the different colored portions are colored as they are carved so as to prevent mixing colors.

4. The final step is to fill the cavity with plaster of Paris. The dry powder is tamped into the cavity with a scriber or pointed stick. Be sure the cavity is solidly packed with powder. Then apply just enough water with an eye dropper to "wet" the plaster of Paris. After it is completely moistened it will set and form a permanent packing. For special effects, sometimes the plaster of Paris powder is put in before the dye. In this case the dye may be used instead of water to cause the powder to set. The undersurface of the cavity is usually left not quite full, and wax, lacquer, or paint is used to provide a harder and more durable surface than would be the case if the plaster of Paris surface were exposed.

This fascinating craft is growing by leaps and bounds. Some of the carved objects now being displayed in various stores are truly artistic masterpieces. After all, there is no thrill quite the equal of that experienced by creating something that is judged by others to be of superior quality. Interior carving provides a medium in which even the amateur may find satisfying success.

Process No. 19. Spindle Carving

Much of the carving done commercially or in specialty shops is accomplished by spindle carving equipment of the type shown in Fig. 51. This type of tool can be easily set up in the home or school shop. The motor should have a rating of about 1/10 hp. and a very high speed (about 5000 r.p.m.). The cutters are available at supply stores but may be made from notched washers of brass, bronze, or steel. Be sure to file the notched teeth symmetrically and concentrically to prevent vibration at the necessary high speed. For best results the teeth must be filed so that they have "relief" on the outer portion thus allowing only the sharp cutting edges to touch. Usually the front edge of the tooth should be filed so that it is part of a radius of the outer circle. The piece to be carved is held in the hand or fastened to a piece of wood. The cutters for this tool must be sharp and, therefore, there is danger in coming in contact with them while they are rotating. It is better wherever possible to fasten the piece to be carved on a piece of wood or a special jig.

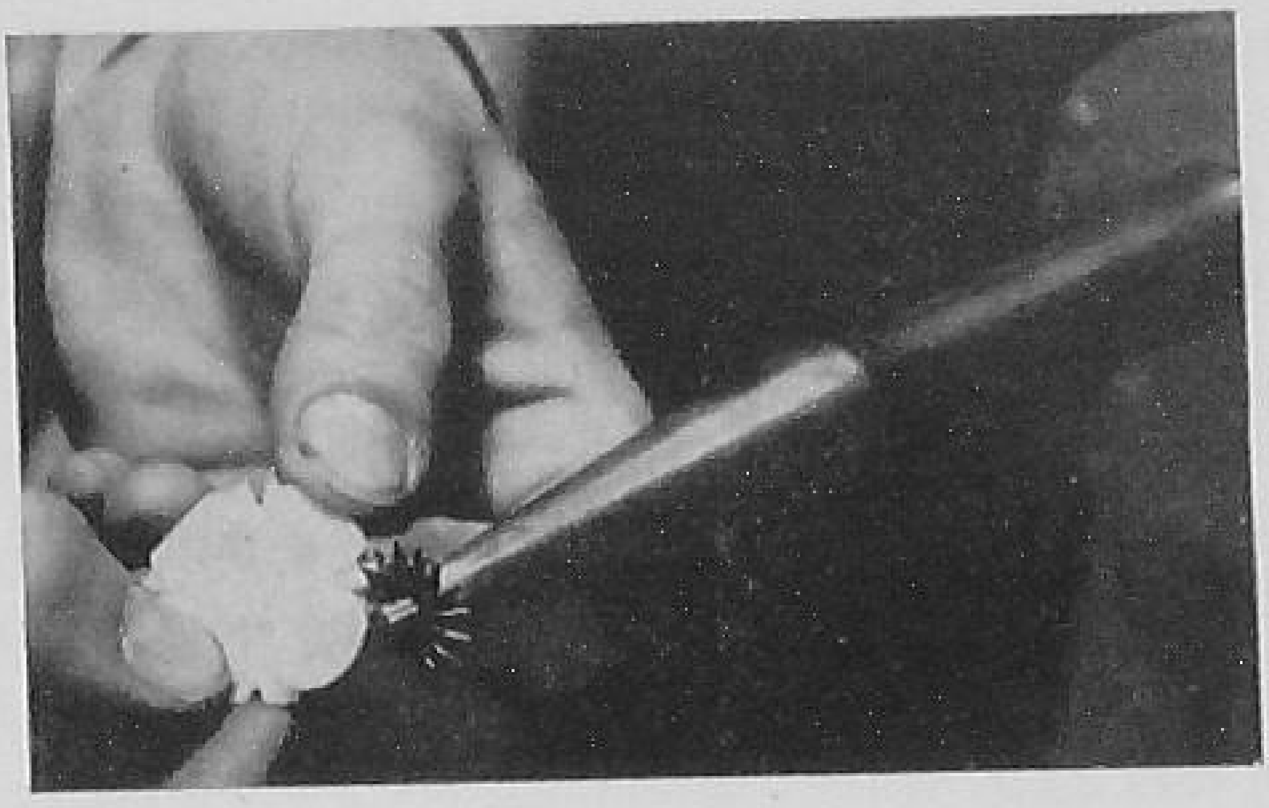


FIG. 51. Professional type of high-speed carving-spindle.

Process No. 20. Inlaying

Many interesting contrasts and decorative effects may be obtained by the process of inlaying. This process is usually done with fairly thin sheet plastic and two or more contrasting colors may be used. The sheets of plastic are bound together with masking tape with the design traced on the top sheet (Process No. 4). The design must be such that definite areas are involved so that these areas may be sawed out and corresponding areas from the under sheets substituted as desired in the final make-up. The

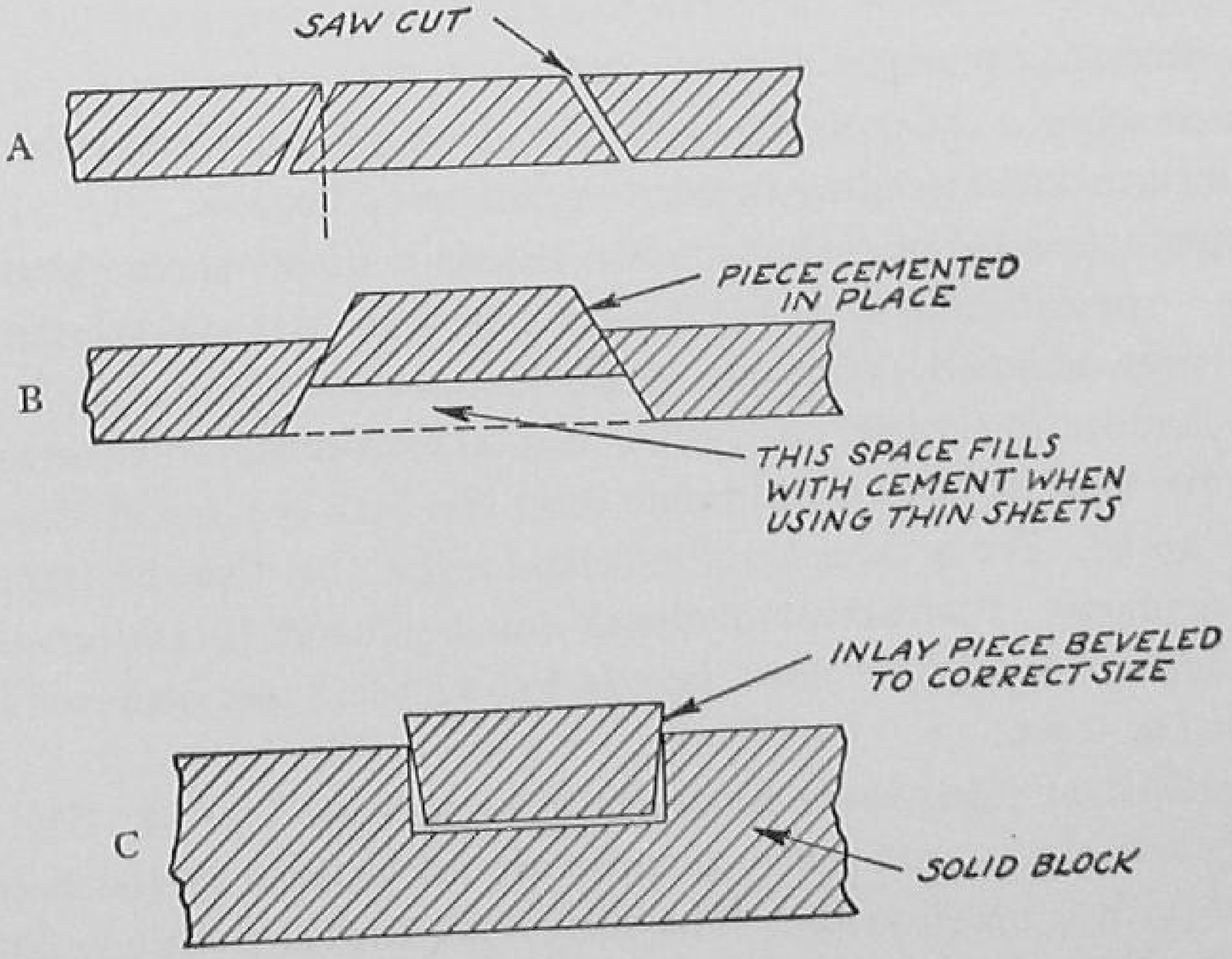


FIG. 52. Inlaying.

areas are sawed out with a very fine jeweler's saw. The finer the blade the less effect the saw kerf has on the finished design. If the areas to be sawed out do not extend to the edge of the sheets, a very small hole must be drilled in the least conspicuous place possible to insert the saw. Refer to Process No. 5.

The pieces are then assembled and cemented in position on a suitable support. If only two sheets are used and it is a simple design, it is good practice to tip the saw in such a manner that the bottom of the pieces that are to be cut out are larger than the top of the holes left in the top sheet (Fig. 52A). In this case, when the pieces are cemented into position they can be made to fill the entire space so that very little, if any, joint is visible. With this method the inserted pieces protrude above the surface of the top sheet and must be sanded down before polishing (Fig. 52B). When pieces are to be inlayed in a solid block, the inlay is beveled to the correct size so that it makes a tight joint (Fig. 52C). This process is quite difficult for any but simple designs. The method of cutting grooves for the inlaying pieces is described in Process No. 24 (Fig. 58). This type groove may easily be made by an electrical router. If this machine is used, be sure that the work is securely clamped to a firm support.

Process No. 21. Fastening with Machine Screws

It is sometimes desirable to fasten two pieces of plastic material together or to a dissimilar material with a machine screw. This is of particular importance when a difficult assembly is to be made that otherwise would require a complicated holding jig for the cementing process.

Machine screws are manufactured in standard diameters designated by numbers. They include a wide range of standard and special sizes with various types of heads. They are threaded for about ¾″ of their length and the number of threads per inch is also standardized. The sizes often encountered in plastic work will range from No. 4 to No. 8 with lengths of from ⅜″ to 1″. For a "No. 6-32" machine screw the "No. 6" indicates a definite diameter. The actual diameter can be found in any convenient metal working book. The "32" stands for 32 teeth per inch which are found on the screw.

The method of using these screws is illustrated in Fig. 53. The screw used here has a flat head and ordinarily would be used in the base of a project to hold a piece on top. The piece "B" is drilled with a hole size which will allow the screw to slide through easily. This is called the body

hole. The bottom of the hole is countersunk so that the head will go in sufficiently to keep it from protruding below the bottom of piece "B." The top piece "A" is drilled with a hole size that is smaller than the body hole and must be ascertained from metal working tables. This is called the "tap hole" and is of the correct size to allow threads to be formed in it that will receive the machine screw threads. The method of tapping the hole is described in Process No. 22. The screw is driven with a screw driver and will pull piece "A" to piece "B" with tremendous force. Round

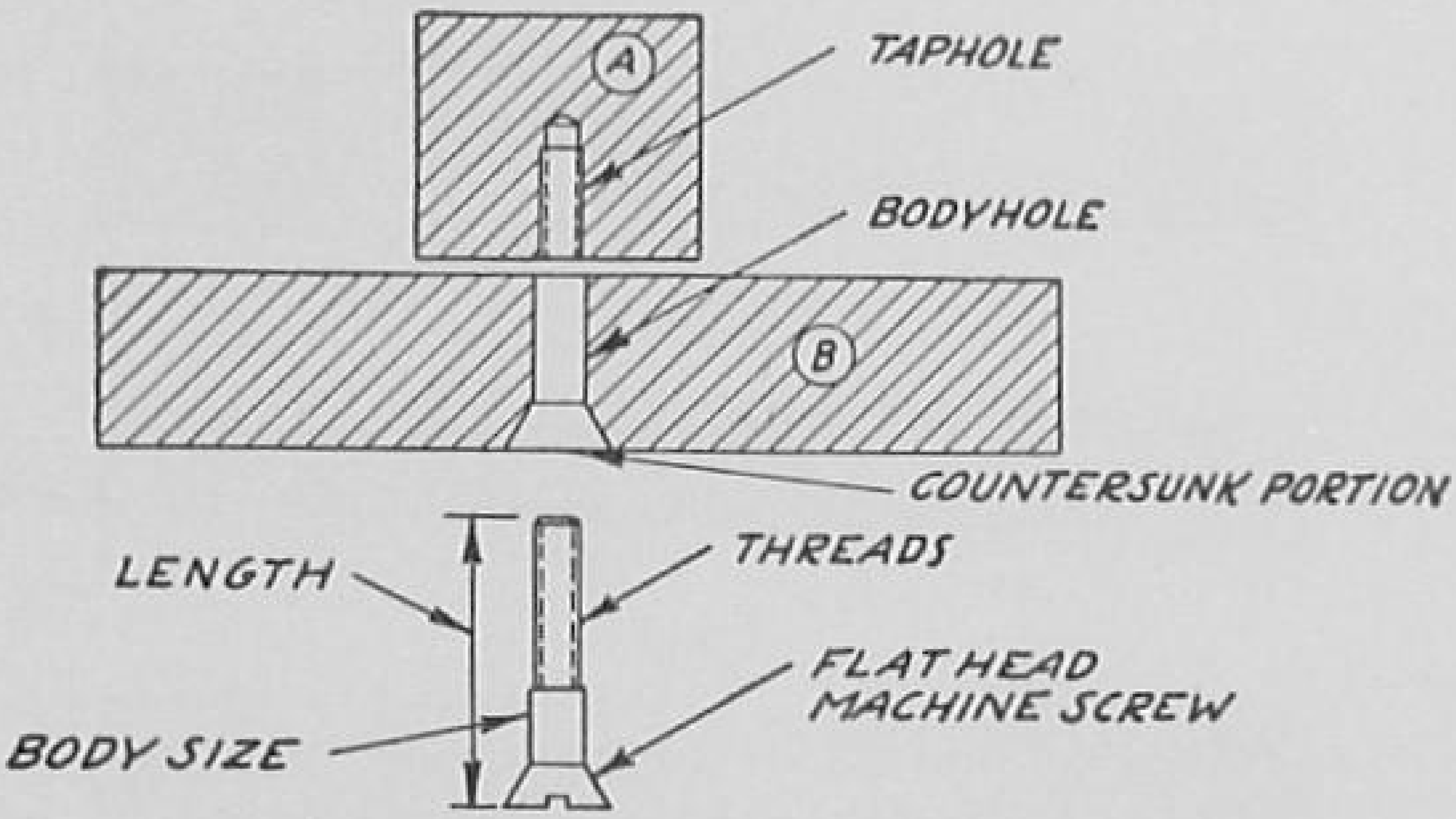


Fig. 53. Fastening with machine screws.

head screws can be used where the protruding head is permissible or desired.

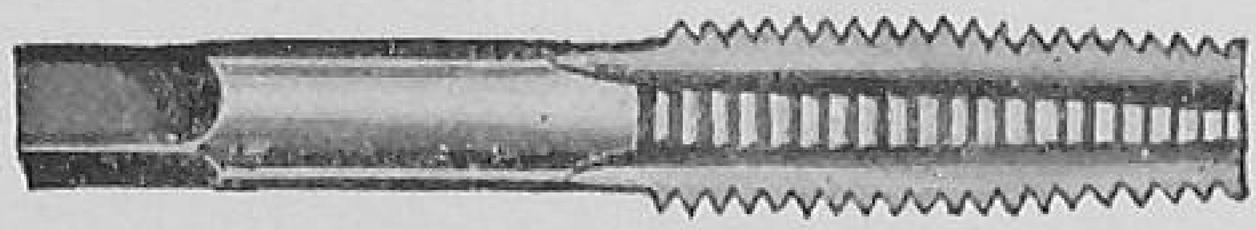
Process No. 22. Cutting a Thread

Threads are cut in holes with a tap. The tap is a round piece of tool steel with a thread at one end and a square shank on the other (Fig. 54). The threaded portion has grooves cut in it parallel with the axis, which forms the cutting edges and allows space for the shavings. Taps are available in three forms—the taper, the plug, and the bottoming types. For starting a thread the taper form is ordinarily used (Fig. 55). The plug and bottoming forms are used when the threads are to extend nearly to the bottom of the hole. (Refer to Process No. 29 for tap drill sizes).

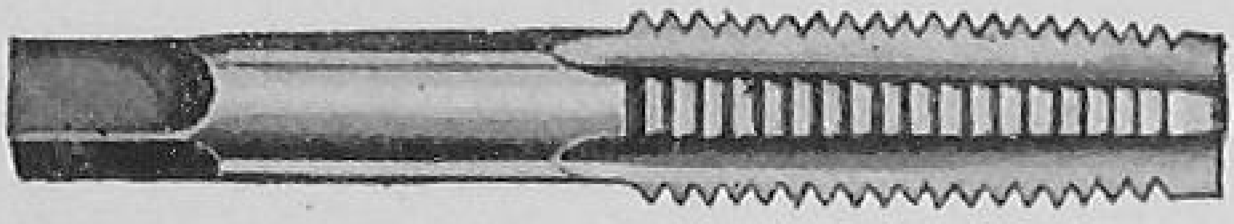
After the proper sized tap hole has been drilled the taper tap is turned into it by a tap wrench which fits the squared end. The tap hole sizes specified in metal working tables are those required for metal. It is good practice to drill tap holes in plastic materials a few thousandths of an inch

(depending upon the size) larger than those specified for metal. The size tap used must, of course, match the size of the screw for which the thread is being prepared. Be sure to keep the tap axis in line with the hole. After every few turns, turn a little in the opposite direction to break the chips that form. For deep holes the chips should be cleared by entirely removing the tap during the threading process. Turn with a slow, even motion and lubricate with liquid soap solution.

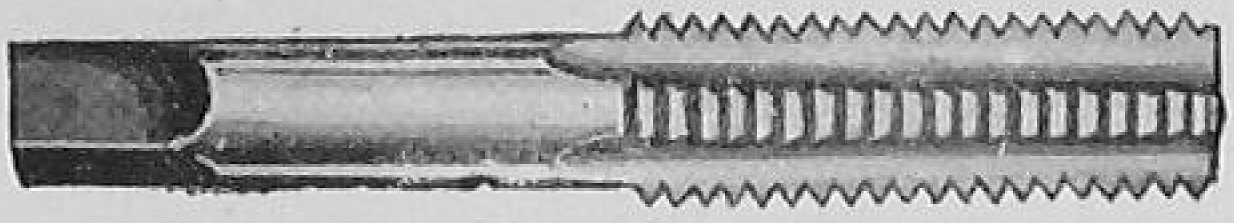
Threads are cut on the outside of a rod with a die. Dies are made in many different forms, some of which are adjustable. They are usually



Taper.



Plug.



Bottoming.

FIG. 54. Hand taps.

cylindrical and are threaded similar to a nut. The cutting edges are formed by channels through the threads, parallel with the axis, and deep enough to allow space for the shavings. The die sizes are standardized and dies usually come in sets.

To cut a thread on a plastic rod, the rod is held in the wood vise and the die turned on to the rod by means of a special wrench or "diestock" (Fig. 56). It is important to keep the axis of the die lined up with the axis of the rod. Turn in a clockwise direction using some downward pressure at the start. Reverse the direction of rotation every few turns to break the chips. Lubricate with liquid soap if necessary. Most dies are adjustable. A little screw is provided in the side of the split die which may be turned in or out to change the diameter of the threads slightly. For plastic pieces the threads should not be too tight. It is not always advisable to use this type of joinery on transparent plastic as the constructional details will be very noticeable.

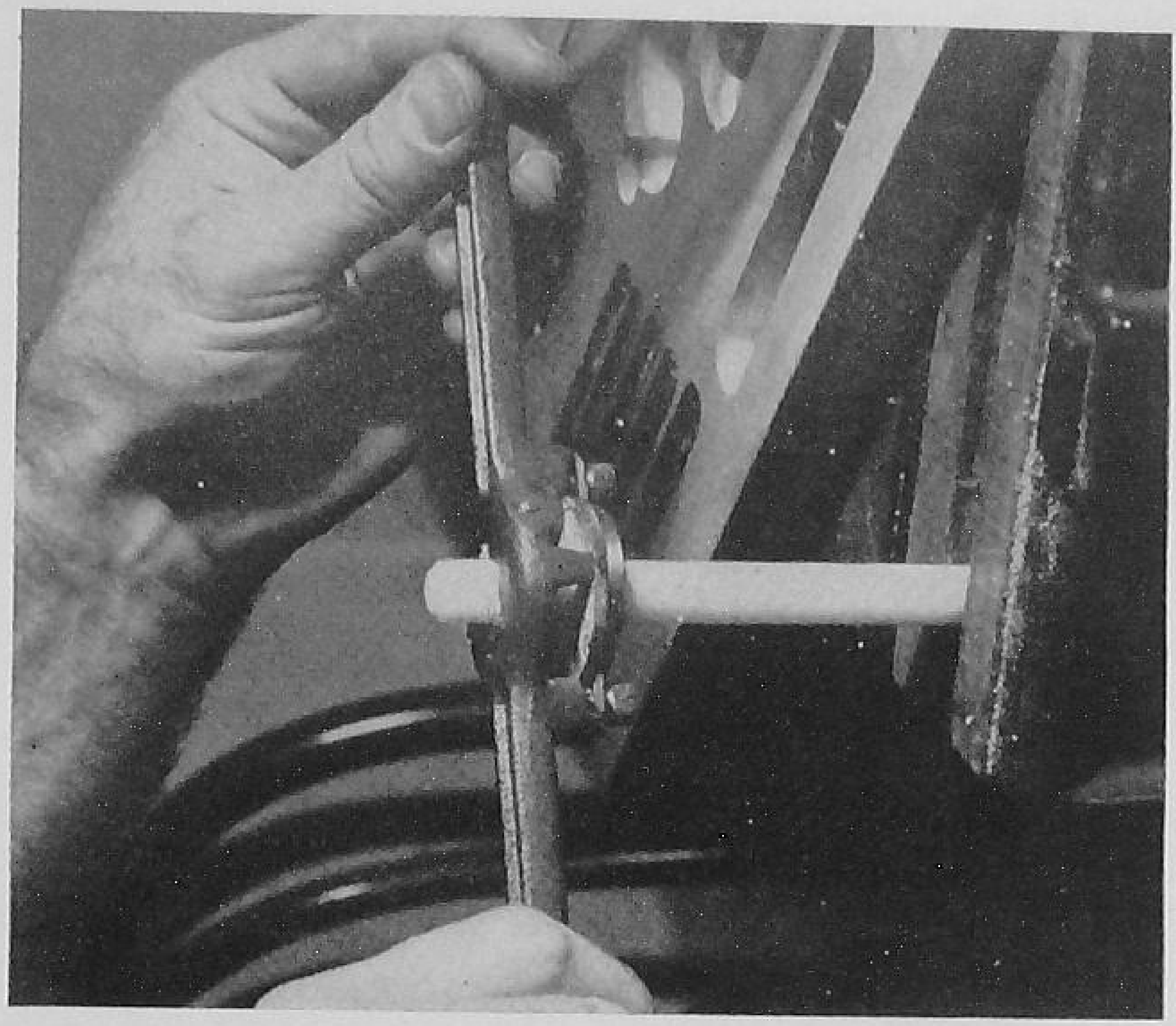


FIG. 56. Cutting a thread with a die.

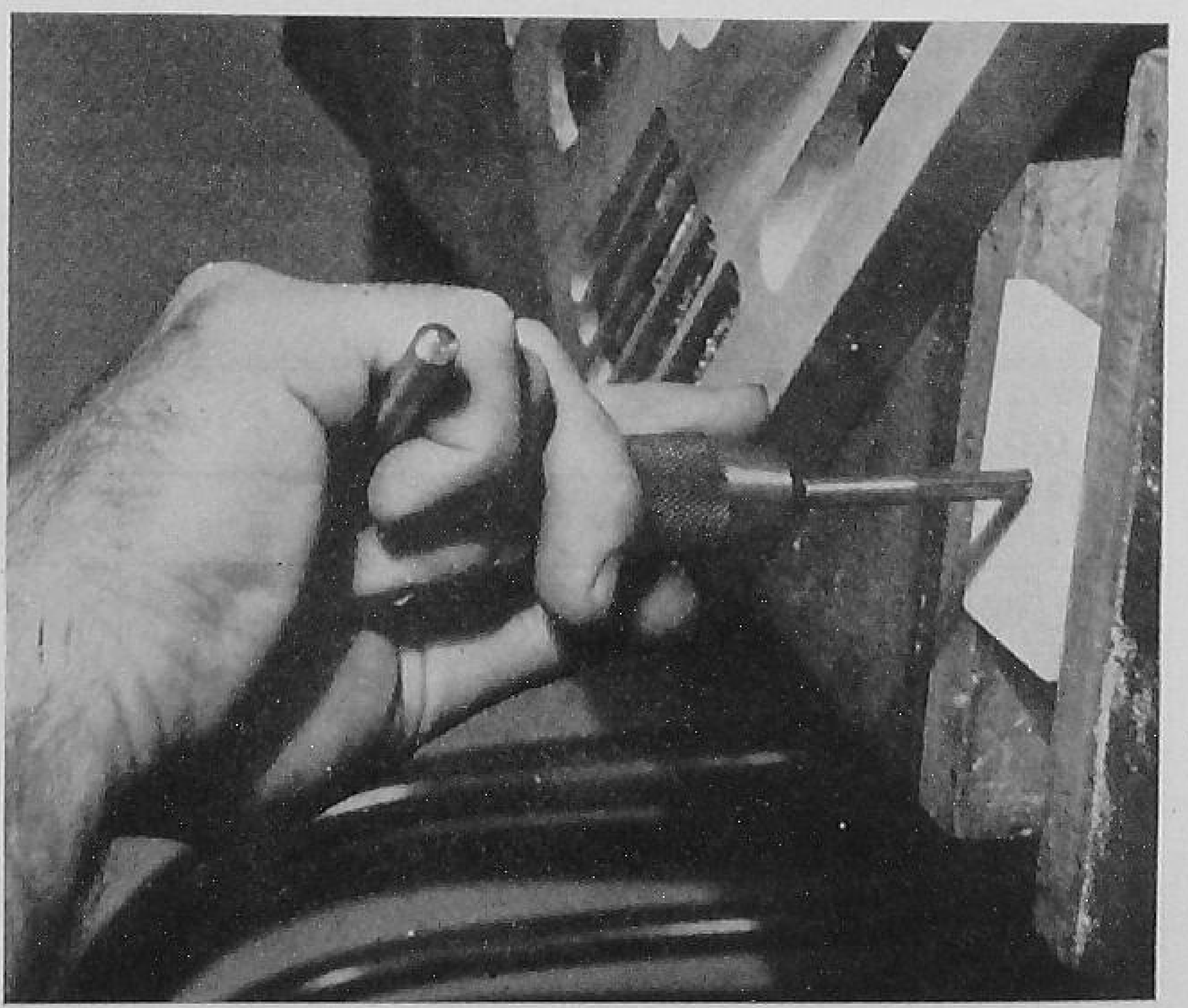


FIG. 55. Cutting a thread with a tap.

Process No. 23. Fastening with Drive Screws or with Self-Tapping Screws

The method of preparing holes for these screws is much the same as that used for machine screws. The main difference is that the tap hole is not

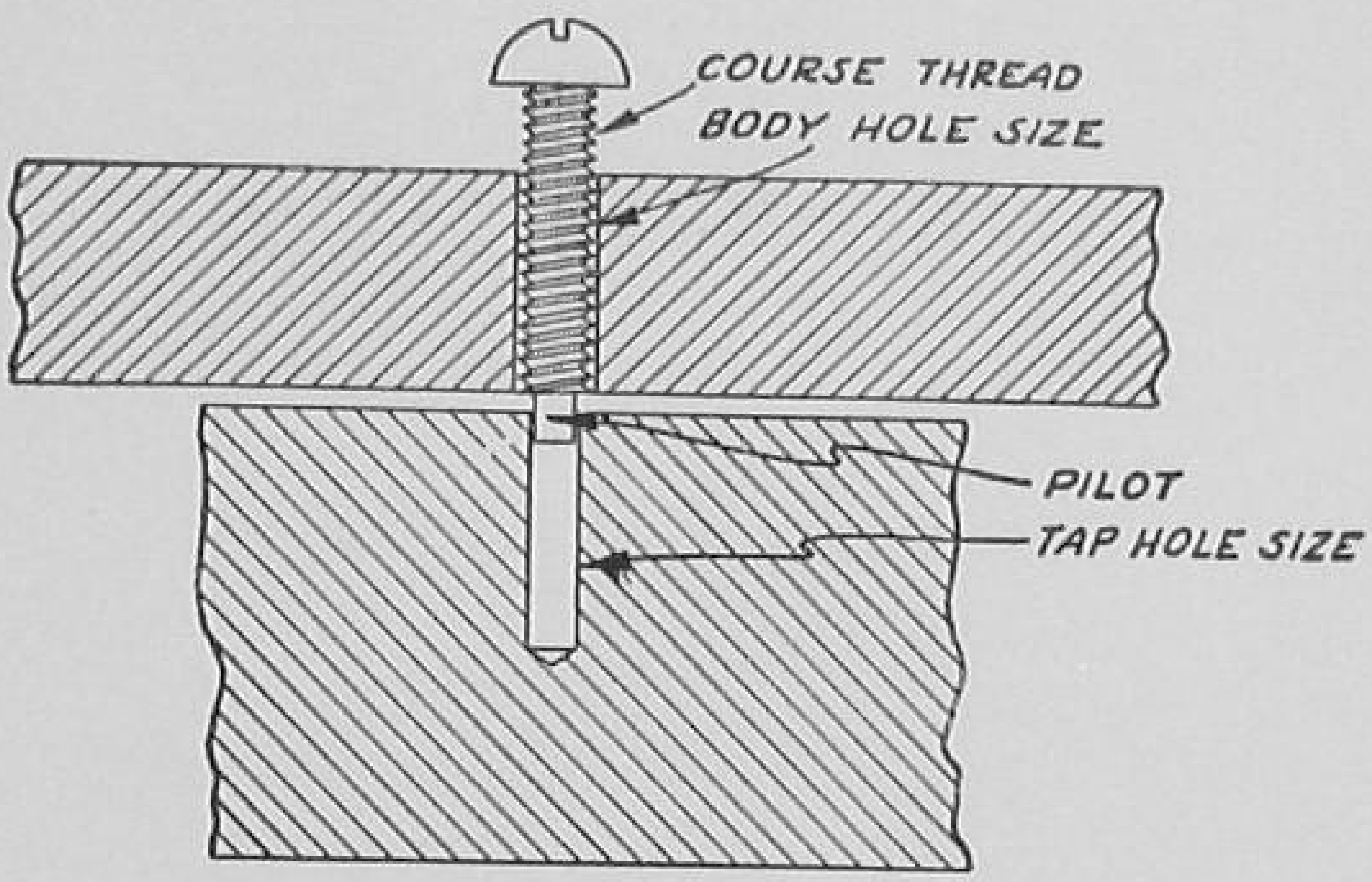


FIG. 57. Fastening with drive or self-tapping screws.

threaded because the screws form their own threads (Fig. 57). The body and tap holes are drilled according to the specified hole sizes and then the screws are either driven in with a hammer or screwed in with a screw driver. Both of these types have threads cut on them that are forced into the tap hole, cutting their own thread as they go in. The following Tables provide information concerning hole sizes for self tapping screws and drive screws.

SELF TAPPING SCREWS

Size	O.D. Thread	Thermosetting		Thermoplastic	
		Hole	Drill	Hole	Drill
2	0.086	0.078	47	0.078	47
4	0.112	0.099	39	0.093	42
6	0.137	0.128	30	0.120	31
7	0.151	0.136	29	0.128	30
8	0.163	0.149	25	0.144	27
10	0.186	0.177	16	0.169	18
12	0.212	0.199	8	0.191	11
14	0.243	0.234	15/64	0.221	2

DRIVE SCREWS

Size	O.D. Thread	Plastics	
		Hole	Drill
00	0.058	0.052	55
0	0.073	0.067	51
2	0.098	0.086	44
4	0.114	0.104	37
6	0.138	0.120	21
7	0.152	0.136	29
8	0.164	0.144	27
10	0.179	0.161	20
12	0.209	0.191	11
14	0.239	0.221	2

Process No. 24. Cutting a Groove

The usual manner of cutting grooves involves a power circular saw or a machine router. Grooves may also be cut without too much difficulty by hand. The boundary lines of the groove are scribed or cut with a sharp knife blade into the surface of the plastic. A piece of metal or hard wood is clamped along one side of the groove exactly on the line. If the groove does not extend the entire length of the piece it is good practice to provide end stops similar to the side stop or guide shown in Fig. 58. This prevents the cutting tool from slipping by the groove end marks. A wood chisel or file end is ground to the required width and used as a scraper. The chisel is held at an angle of about 60 degrees with the surface and pulled along the guide with a scraping cut. The beveled portion of the chisel is on top (Fig. 58). The tool must be kept sharp and the end of the cut should be straightened continually as the groove progresses in depth. Straight grooves extending the entire length may be sawed, usually with a backsaw, on each side of the groove and then the center portion removed with the scraper. For wide grooves the backsaw is used to make a series of small saw cuts and then the remaining material is scraped out to form the grooves.

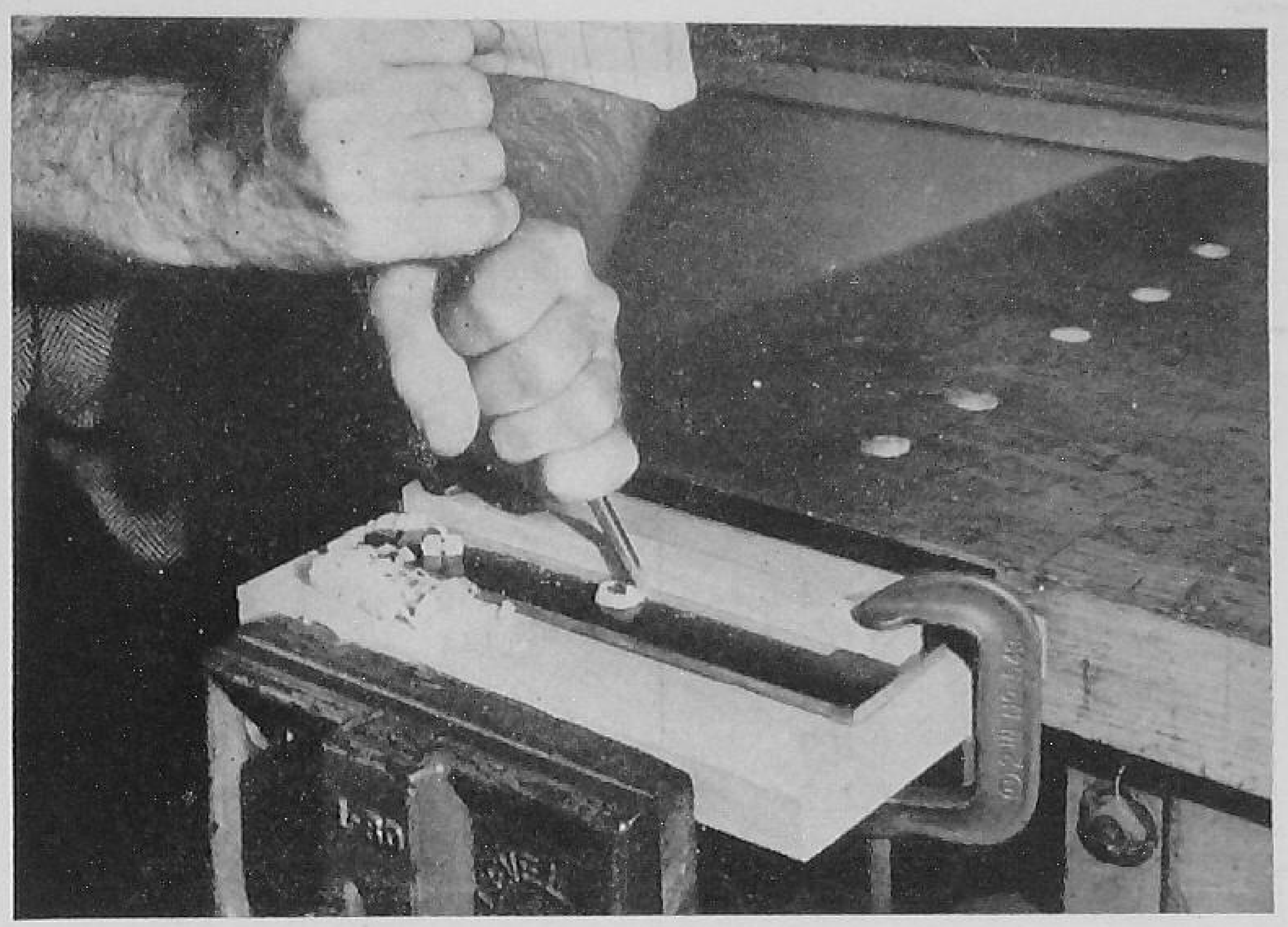


FIG. 58. Cutting a groove.

Process No. 25. Sawing on the Band Saw

The band saw is one of the most useful tools for sawing plastic materials. However, there is always a certain element of danger involved unless the saw is used intelligently. Under no circumstances should it be used without instruction and demonstrations. It consists of a ribbonlike saw blade which travels over a top and bottom wheel. This arrangement provides a continuous row of moving teeth, against which one feeds the material to be sawed. The saw is held against back rotary supports and between stationary vertical guides. It must be well guarded.

These saws will cut plastic material nicely provided that the rate of feeding the material into the saw is quite slow. This is necessary to keep the plastic material from heating and clogging the saw. The saws may be of practically any width from 3/16″ to 3/4″ and should have 9 or 10 teeth per inch for ordinary work and 14 or 15 teeth per inch for fine work. The saw should travel at the rate of about 1500 feet per minute. Saws with a small amount of "set" will do a smoother job of cutting. The thicker the material, the coarser the band saw tooth size should be.

In Fig. 59 the saw is being used to cut a strip from a sheet. A layout

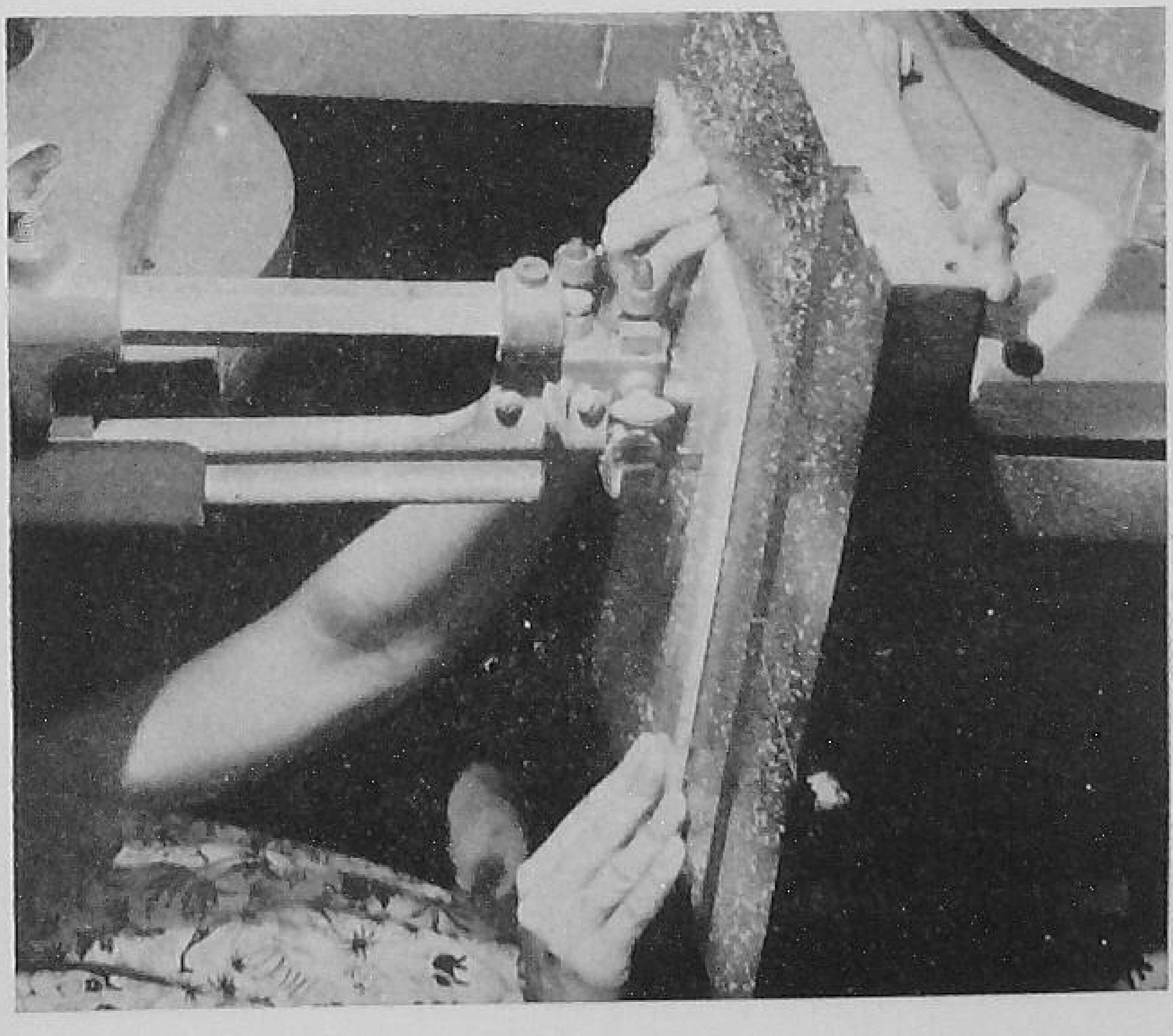


FIG. 59. Sawing plastic sheet on the band saw.

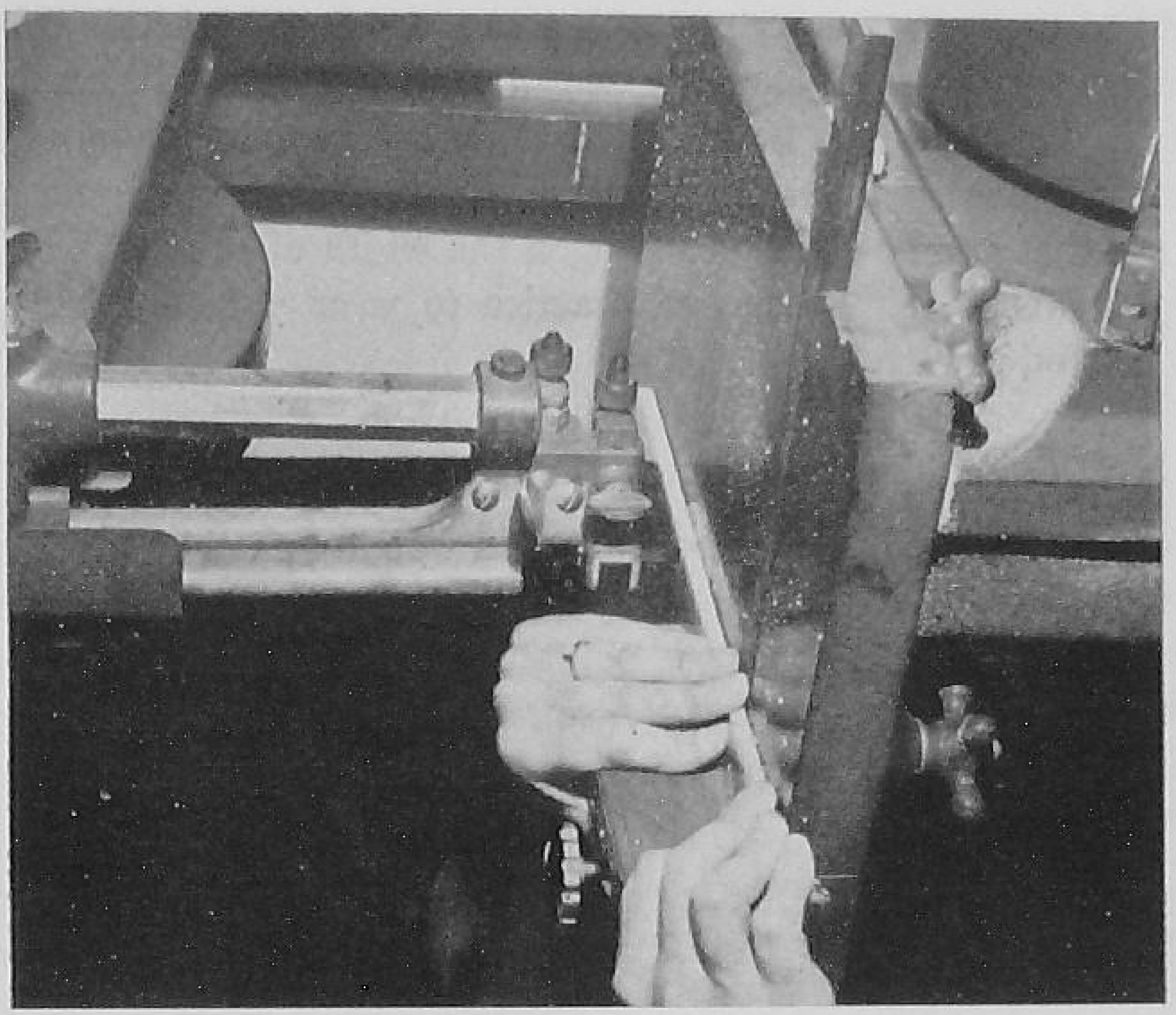


FIG. 60. Making a right-angle cut on a band saw.

line should be made on the surface with a scriber. Some practice is necessary to maneuver the saw along the line in a manner that will result in a straight cut. Fig. 60 shows how a right-angle cut may be made with the aid of a cut-off fence. Curved lines may also be cut. The minimum radius of curvature that can be cut depends upon the width of the blade and the "set" of the saw teeth. It is good practice to wear a face shield while operating a band saw.

Process No. 26. Sawing on the Scroll or Jig Saw

The scroll saw is used to cut curves in thin wood or metal material. By using a blade designed for the purpose and the proper speed, plastic material may be cut easily. The saw is actuated in an up and down motion against the action of a spring, and the saw cuts on the down stroke. Like the band saw, the blade is supported by rotary back supports and station-

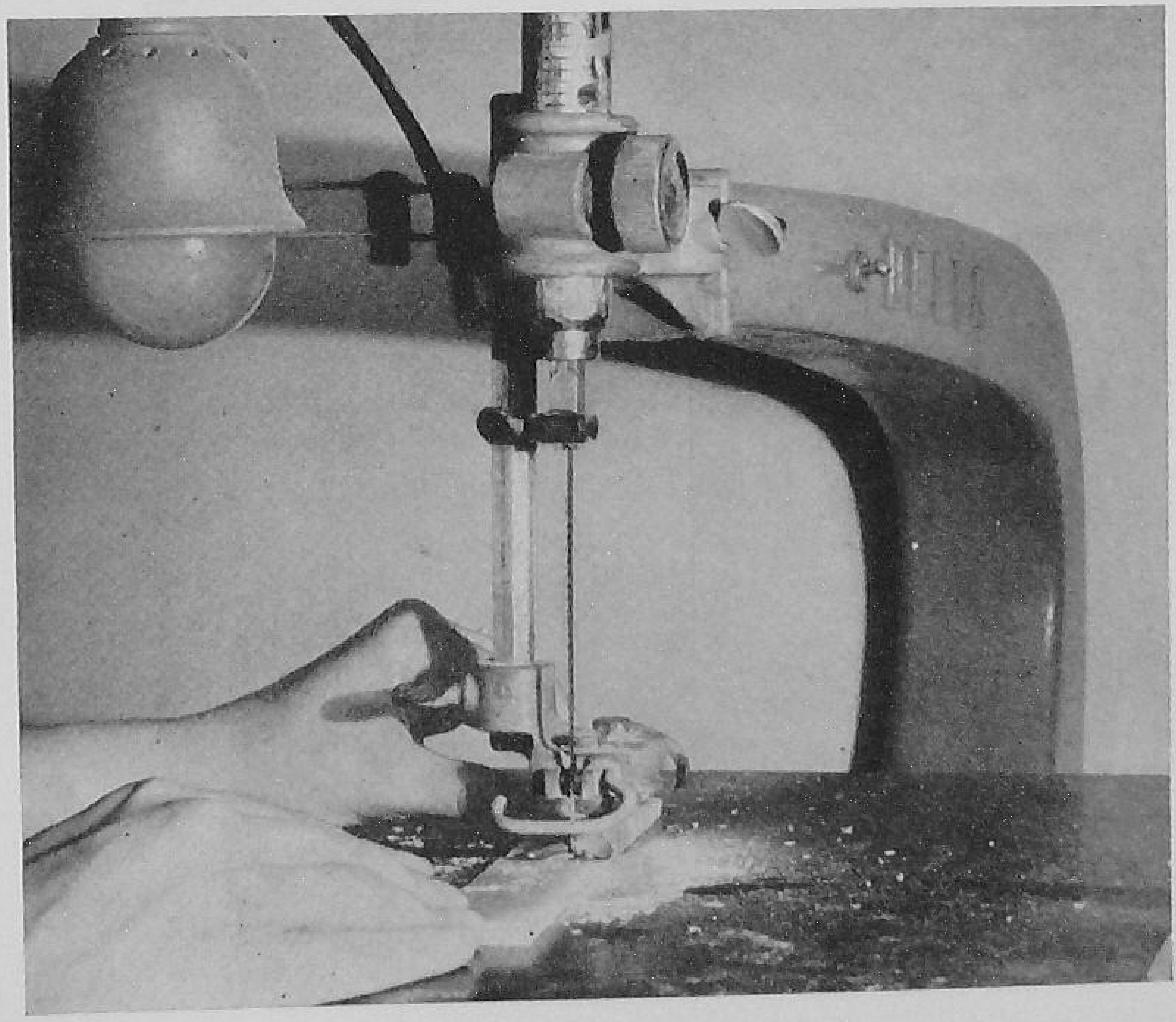


Fig. 61. Sawing on the scroll saw.

ary vertical guides. The saw blades are easily removable and various speeds and blade tensions are provided. The blades should not have too fine a pitch (number of teeth per inch). The blade used depends upon the job but the ones used most often will range from No. 3 to No. 6. The tension on the blade should be less for the smaller sizes. These saws are not dangerous for the beginners to use. It is a very convenient and efficient device which will considerably lighten and expedite the work of plastic fabrication. Fig. 61 shows a scroll saw being used to cut along a curved line.

Process No. 27. Sawing on the Circular Saw

This author does not recommend the use of the ordinary circular saw for cutting plastic material.

The blades used on the ordinary wood circular saw are not designed to cut some plastic materials. They are not hard enough to hold their cutting edges, particularly for the cast phenolics, and do not travel at the most efficient speed (about 3600 r.p.m. for an 8″ to 12″ saw). Also, the teeth have too much "set" which causes a rough cutting action and the heat generated is likely to cause binding, gumming, and burning. Therefore, the ordinary circular saw is not recommended for plastic work. However, a hollow ground high-speed steel blade with little "set" will give fairly good results if the rate of feeding the material to the saw is correctly regulated. If the feed is quite slow, a coolant is not needed. Sometimes a stream of water is used to allow for an increase in the rate of feed and in obtaining a cleaner cut.

The sawing operations are carried out much like those used in wood working and space does not permit detailed description here. To prevent chipping, the height of the saw blade above the surface of the plastic material should not exceed $\frac{1}{16}$″. The beginner should not, under any circumstances, use this type of saw unless he has adequate guidance from an experienced teacher.

Process No. 28. Sanding on the Belt and Disk Sander

After one has mastered the technique of hand sanding, much of the hard work and time involved may be avoided by using the combination belt and disk sander. This device may be used to give the final shape and dimensions to plastic parts as well as to smooth the surfaces. A coarse belt or disk will cut away a plastic surface very rapidly. At least three different grades of abrasive belts and disks should be available. The belts may be

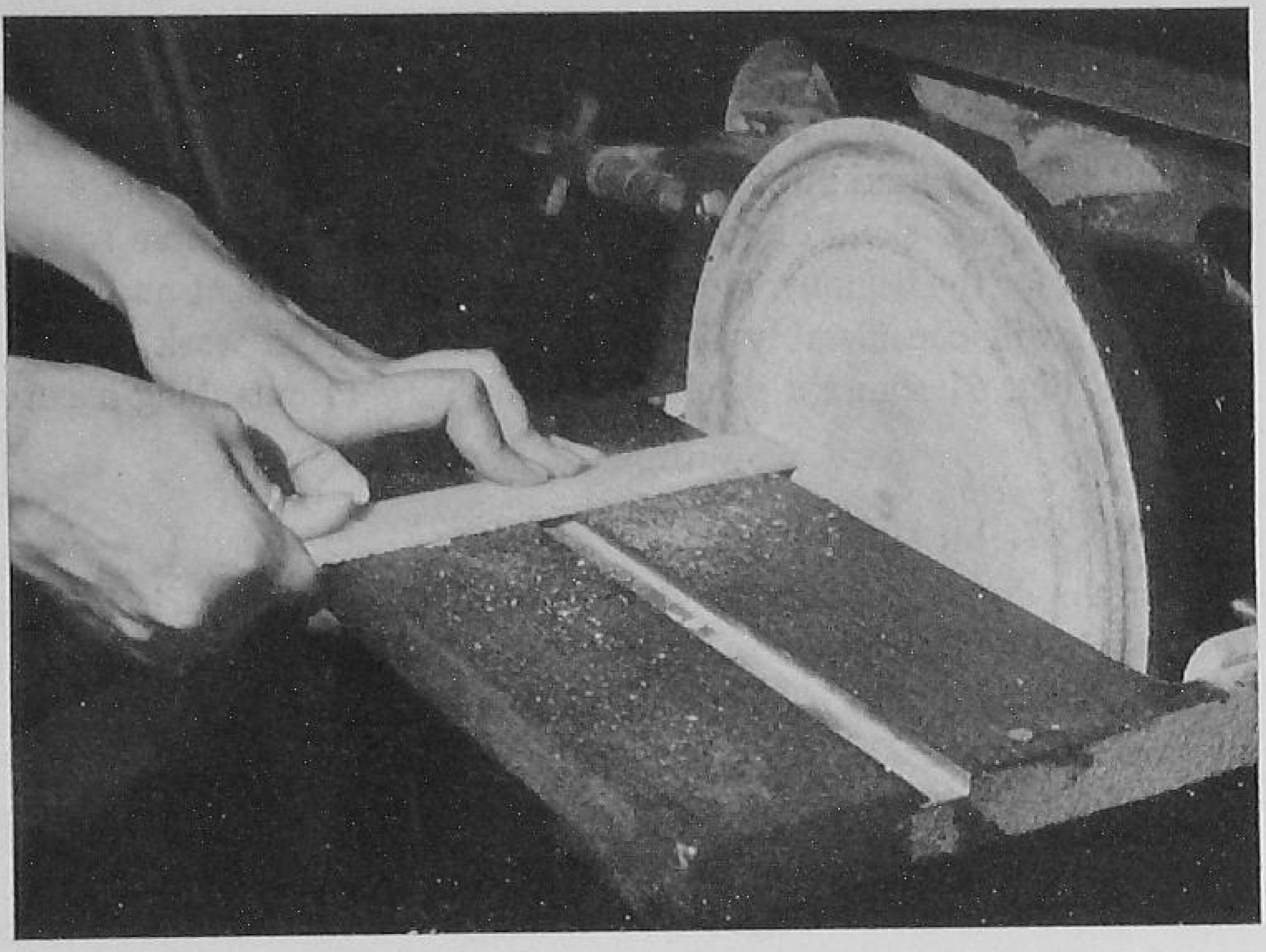


FIG. 62. Sanding an end on disk sander.

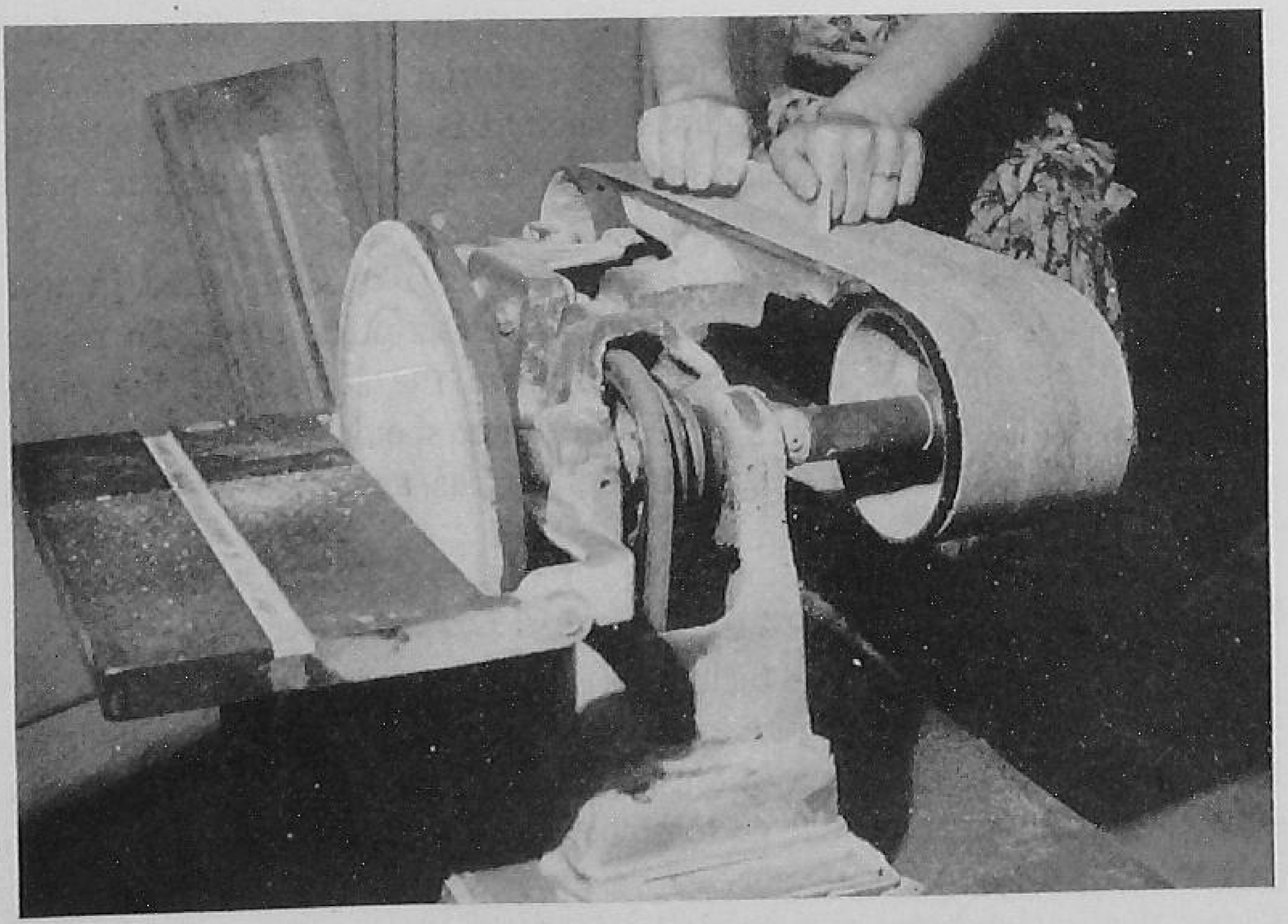


FIG. 63. Sanding an edge on belt sander.

glued up from sand-belt stock or bought already to slip on the machine. The disks are ordinarily bought in correct sizes to avoid waste in cutting. The disks are glued or cemented to the drum, preferably with one of the commercial adhesives readily available. Shellac, glue, paper cement, etc., may be used. Garnet paper seems to be the best material for the abrasive belts or disks. The belt sander should run at about 3000 surface feet per minute. It is good practice to wet down the surface of the belt periodically.

Fig. 62 illustrates the use of the sanding disk to trim up a square end. The table holding the work is adjustable so that angular work may also be sanded. Fig. 63 shows the sanding belt being used to sand an edge. A stop may be attached to the belt sander which allows angular shapes to be supported while being sanded.

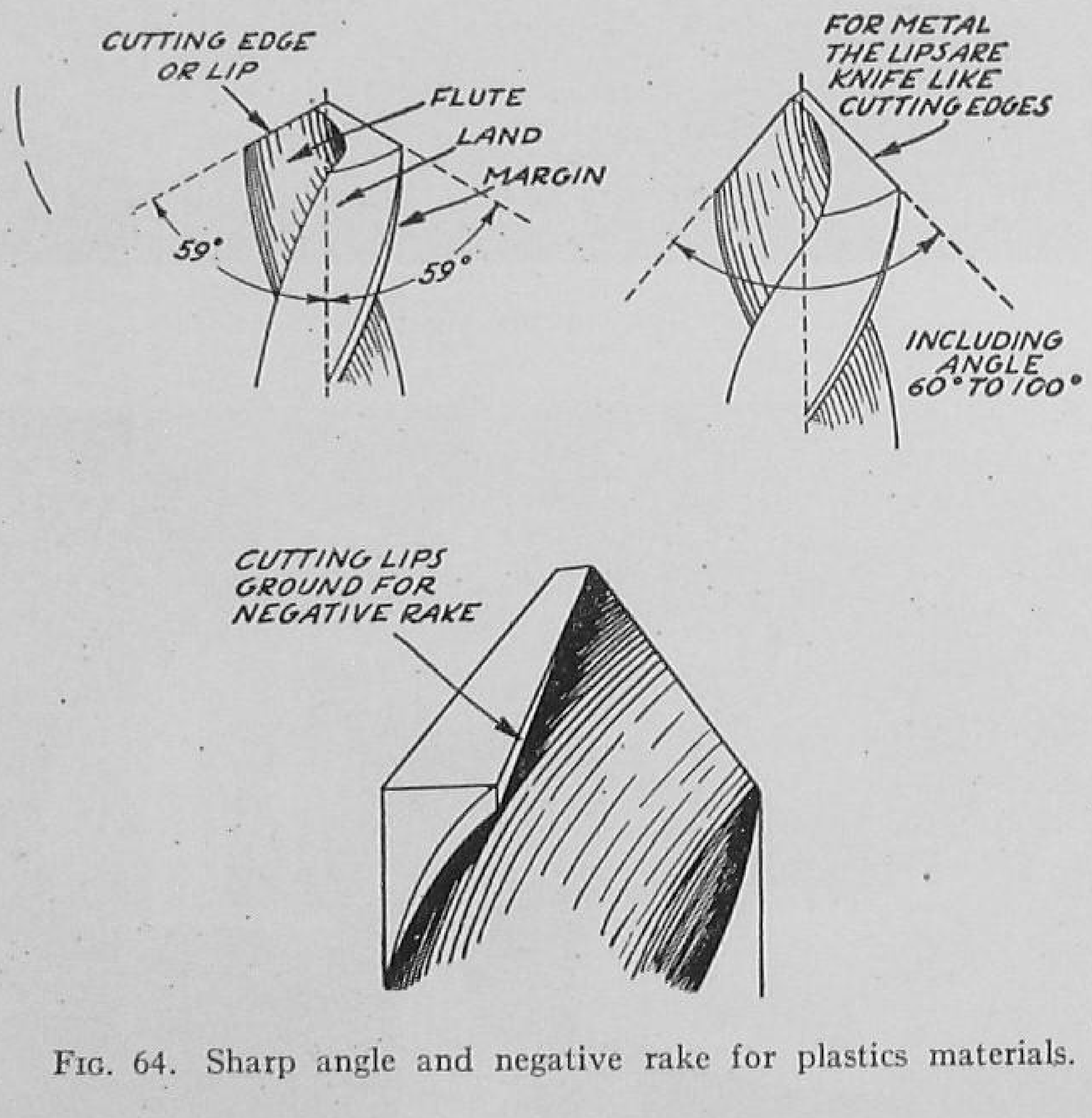


Fig. 64. Sharp angle and negative rake for plastics materials.

Process No. 29. Drilling on the Drill Press

The drill press is available in either bench or floor models. The size is often designated by the diameter of the circle at whose center a hole may be drilled. Sometimes the size is also specified by the capacity of the chuck, such as a ½″ chuck. The drills used for small holes under ¼″ are

those designed for metal working. These standard drills have a tendency to "grab" into plastics and care must be taken to maintain a very light, even pressure. For the larger holes the drill should be ground with a neutral or negative rake (Fig. 64). The included angle for the tip is

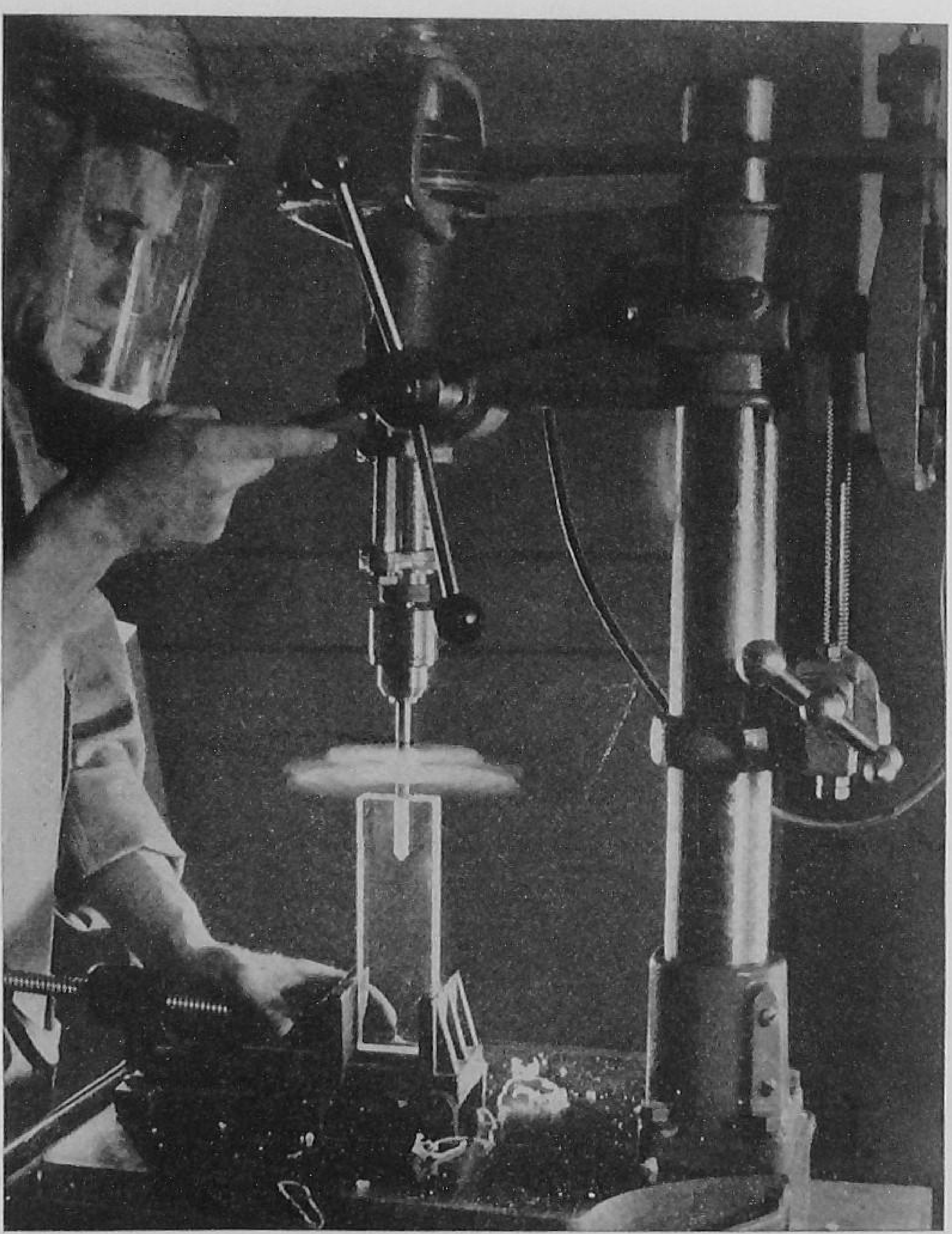


FIG. 65. Drilling a transparent "Lucite" sheet. (*Courtesy of E. I. Dupont de Nemours & Company*).

changed from 128 degrees to a much sharper angle. About 80 degrees will work well. (The Du Pont Company recommends a flute angle of 17 degrees, a lip angle of 70 degrees, a lip clearance of 4 to 8 degrees, and polished lands one-fourth the width of the heel.) These modifications provide smooth scraping cuts which prevent "digging in" and aid in keeping the drill from breaking through and grabbing at the bottom of the hole. (Beginners should practice grinding drills only after instruction from a competent machinist. The process looks simple enough but is rather tricky to do without a good deal of practice.) For the larger holes, or for cutting disks, the standard hole saw or fly cutters operated at a low speed will

TAP DRILL SIZES FOR PLASTICS

FOR		FOR		FOR		FOR	
Tap	Drill	Tap	Drill	Tap	Drill	Tap	Drill
0 x 80	55	8 x 30	28	16 x 16	3	N.	C. S.
1 x 56	1/16	8 x 32	28	16 x 18	7/32		
1 x 64	52	8 x 36	27	16 x 20	2	¼ x 20	5
1 x 72	51	9 x 24	27	17 x 16	1	5/16 x 18	G
2 x 48	49	9 x 28	25	17 x 18	A	⅜ x 16	O
2 x 56	48	9 x 30	24	17 x 20	B	7/16 x 14	⅜
2 x 64	48	9 x 32	24	18 x 16	B	½ x 13	7/16
3 x 40	45	10 x 24	22	18 x 18	D	9/16 x 12	31/64
3 x 48	44	10 x 30	19	18 x 20	E	⅝ x 11	17/32
3 x 56	43	10 x 32	19	19 x 16	E	¾ x 10	21/32
4 x 32	42	11 x 24	17	19 x 18	F	⅞ x 9	49/64
4 x 36	42	11 x 28	16	19 x 20	G	1" x 8	⅞
4 x 40	41	11 x 30	16	20 x 16	H		
4 x 48	40	12 x 20	16	20 x 18	I	N.	F. S.
5 x 30	37	12 x 22	15	20 x 20	J		
5 x 32	36	12 x 24	13	22 x 16	L	¼ x 28	2
5 x 36	36	12 x 28	12	22 x 16	M	5/16 x 24	I
5 x 40	34	13 x 20	12	24 x 14	5/16	⅜ x 24	R
5 x 44	35	13 x 22	10	24 x 16	O	7/16 x 20	25/64
6 x 30	32	13 x 24	9	24 x 18	P	½ x 20	29/64
6 x 32	31	14 x 20	6	25 x 14	Q	9/16 x 18	33/64
6 x 36	31	14 x 22	5	26 x 16	11/32	⅝ x 18	37/64
6 x 40	⅛	14 x 24	4	28 x 14	23/64	¾ x 16	11/16
7 x 28	⅛	15 x 18	5	28 x 16	U	⅞ x 14	13/16
7 x 30	⅛	15 x 20	4	30 x 14	W	1" x 14	15/16
7 x 32	30	15 x 22	3	30 x 16	X		
8 x 24	29	15 x 24	7/32				

serve. Use a soap and water or water-soluble oil coolant. Flat faced drills are often used on thin sheet plastic.

The small-size drills may be used without modifying the cutting edges if the pressure is very light and the speed very high. For drills under ¼″ the speed should be the highest that is provided on your drill press. For the larger drills the speed may be slower. In general, good results will be obtained if the following suggestions are observed:

1. Use a correctly sharpened drill tightly clamped in the chuck.
2. Do not hold the piece being drilled in the hand. Clamp to the bed, hold in a vise, or, for small pieces, use a small hand clamp.
3. Make a center punch, or scriber mark at the correct location of the hole.
4. Use proper speeds.
5. Do not drill into pieces that will bend under the pressure of the drill. The pieces must be well supported, preferably on hardwood.

Fig. 65 shows the drill press being used correctly in drilling plastic pieces. In addition to drilling, such work as mortising, shaping, routing, and sanding may be done on the drill press by using special attachments. Be sure to wear a face shield.

Process No. 30. Grinding

The "offhand" grinder is a very handy tool (Fig. 66). Aside from the use to which it is put in grinding metal tools, it also may serve very well to grind plastics. The piece to be ground is held against the wheel at the desired position, and is supported in the hand or by the rest, usually a little above the axis of the wheel. The rest must be adjusted so that it is practically touching the surface of the wheel, so that the piece being ground cannot become jammed between the wheel and the rest. The wheels ordinarily revolve at a peripheral speed of about 5000 feet per minute, which means that a 6″ wheel should turn at about 2700 to 3000 r.p.m.

When grinding plastic materials the wheel should be of the coarse, open, fast cutting variety to keep it from clogging. The manufacturers' specifications should be followed in this respect. Hold the piece firmly and exert a very slight pressure, taking only a light cut and continuing the grinding for only a few seconds at a time. This will insure a smooth cut and good control, and will *prevent heating.*

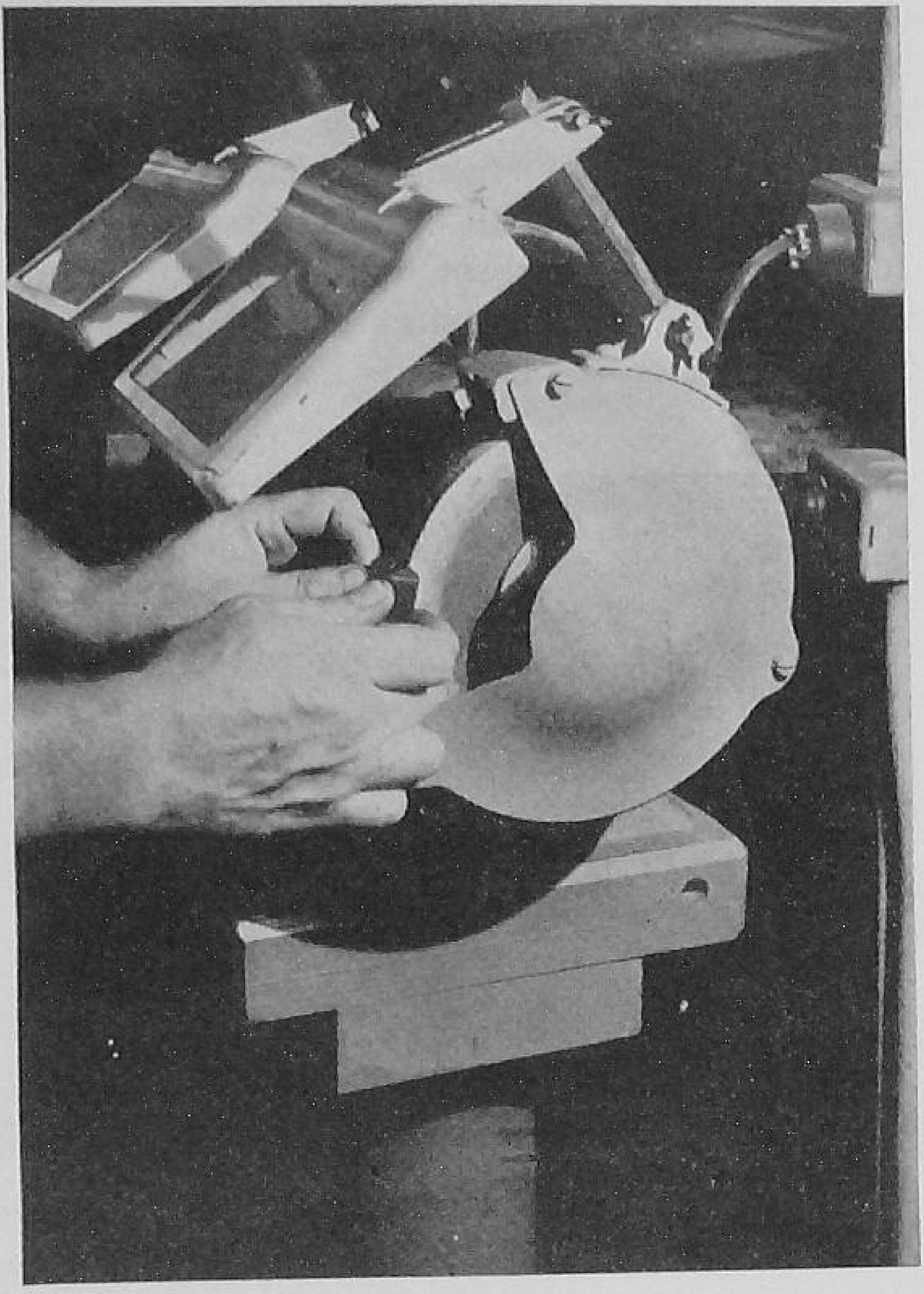


FIG. 66. Grinding plastic ring on offhand grinder.

Process No. 31. Turning on the Wood Lathe

The wood turning lathe is used with hand cutting tools which are brought against the revolving piece. The tools are supported on an adjustable rest and are held at such an angle that they will make a smooth, scraping cut (Fig. 67). The various differently shaped tools are used for obtaining certain special cuts. The beginner is advised to consult a woodworking book for particulars. Practically the only difference between the turning of plastic materials and the turning of wood is in the angle of holding the turning tools. Always a "scraping" instead of a "slicing" cut is used.

A rod may be mounted between centers and turned to the desired shapes.

A center hole and slots for the spurs on the life center should be provided at one end. A "V" type tailstock center is necessary to support the other end. Plastic material will quickly dull the ordinary wood turning tools and therefore they must be sharpened frequently. A high-speed steel metal-cutting tool bit mounted with the aid of set screws in the end of a piece of small pipe will give excellent results. Relatively high speeds are required for turning plastics. Sheet stock may be cemented to a piece of wood and then mounted on the face plate for turning. When working on

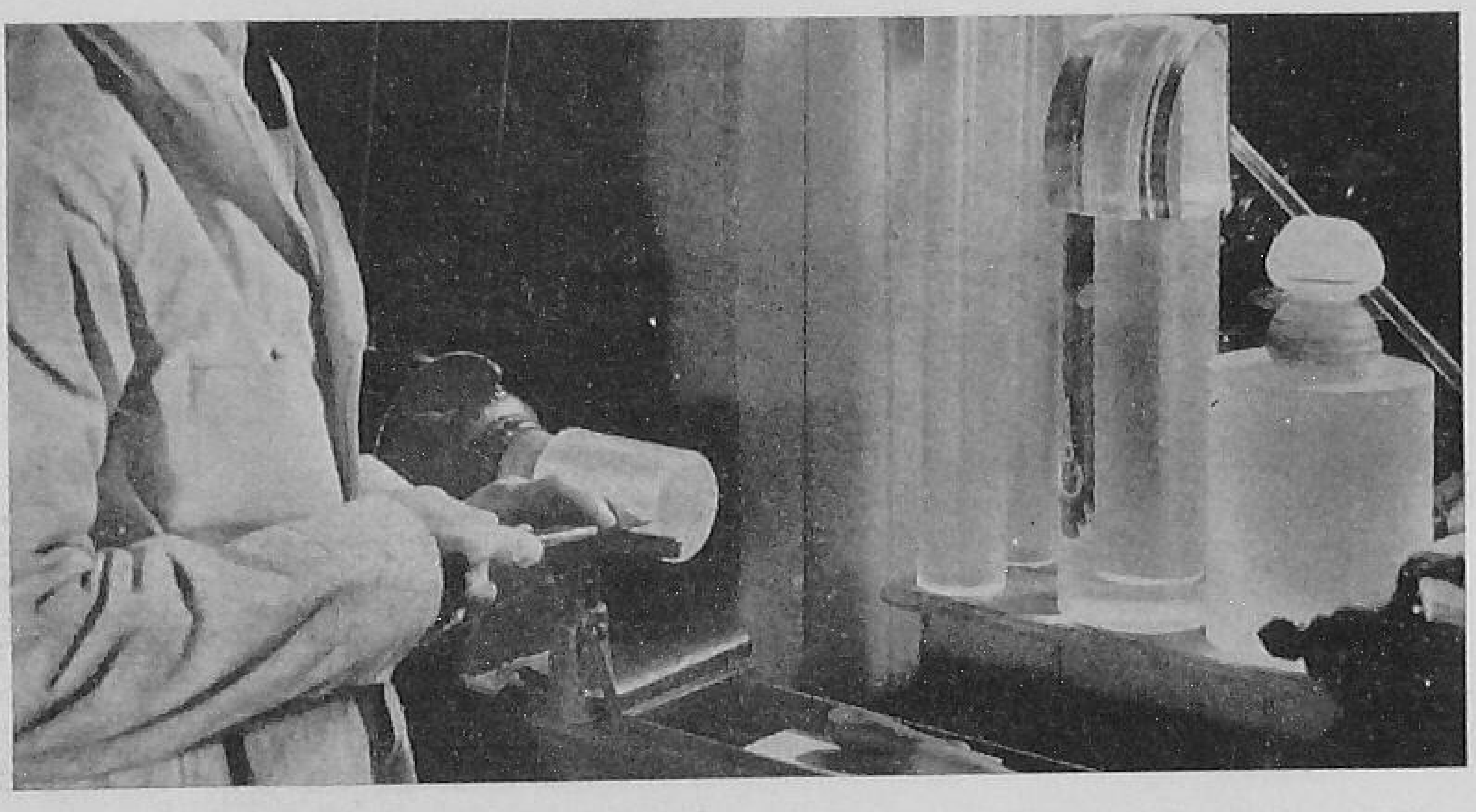


FIG. 67. Machining an opaque "Lucite" tube on the wood lathe. (*Courtesy of E. I. Dupont de Nemours & Company*).

the end of rods it is convenient to cement one end of the rod in a hole bored in a block of wood. This block is then centered on the face plate. Fig. 68 shows such a setup. Cylinders may be mounted on a suitable wooden mandrel for turning.

Sanding and polishing may be done conveniently while the piece is being rotated in the lathe. Figs. 68 and 69 show the processes of turning and sanding, respectively as applied to the end of a rod.

Process No. 32. Turning on the Metal Lathe

This type lathe works on the same fundamental principle as the wood lathe. However, in this case the cutting tool is held in the correct position on a movable rest or "carriage." The rest may be moved by means of a crank or, automatically, by gearing and a clutch. This setup allows an

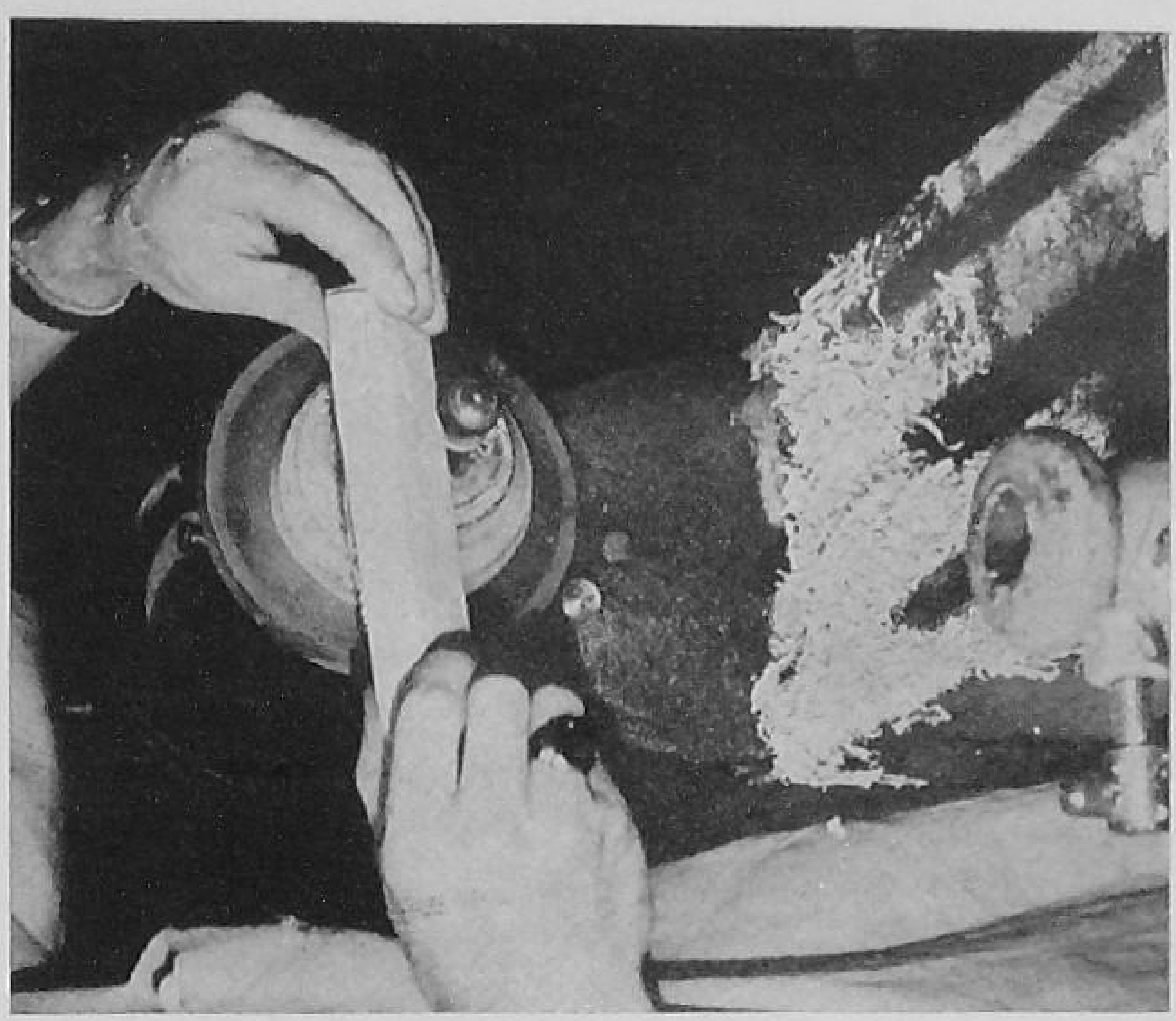


FIG. 69. Sanding on the wood lathe.

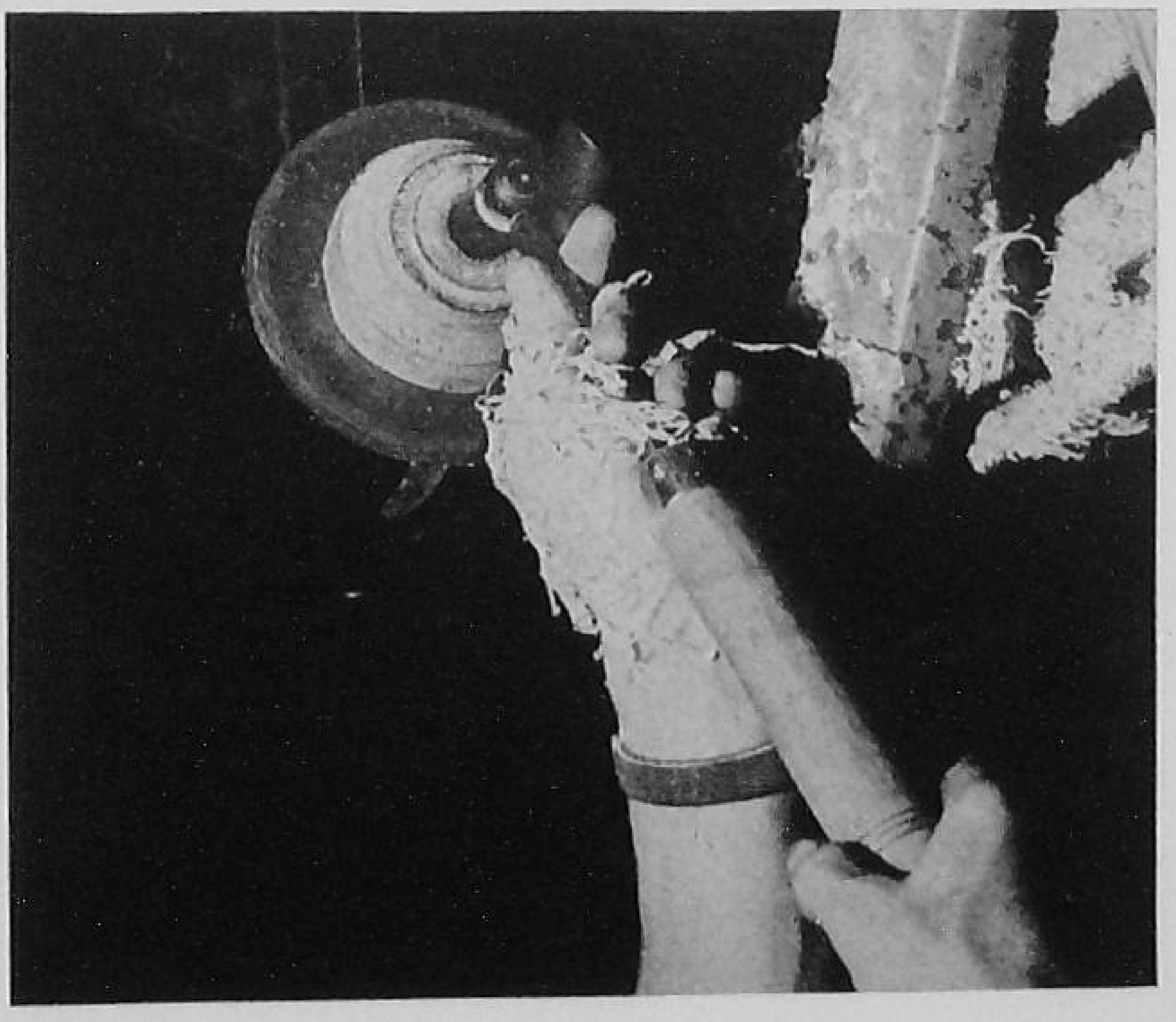


FIG. 68. Turning the end of the rod on a wood lathe.

accuracy not obtainable on the wood lathe.[1, 2] The plastic materials require protection against scarring when held in chucks. High speeds are desirable. Common lathe operations such as turning, threading, and facing may be done easily. In general, the tool bits are ground like those used for brass and copper. The cutting edge should have little or no rake and should be set 2 or 3 degrees above the center line. The cut must be taken with a continuous feed; if the feed is stopped with the cutting tool resting on the work, burning will result. A coolant is not always necessary but a solution of mild soap and water or a water-soluble oil will help in obtaining a smooth cut. Coarse threads are more desirable than the finer ones. Sharp "V" threads are not practical because the sharp apex is likely to fracture. Remember that plastic materials ordinarily expand more than metal and for this reason a good clearance must be allowed when a plastic piece is to be threaded into metal.

The beginner must have adequate instruction and practice before he can use the metal lathe successfully.

[1] John G. Miller, Metal Arts Crafts, New York: D. Van Nostrand Company, Inc., 1948.

[2] Robert L. Thompson, *et al.*, The Home Mechanics Handbook, New York: D. Van Nostrand Company, Inc., 1945.

Chapter X

TYPICAL PROJECTS

Plastic Pins

Plastic pins are easy to make, inexpensive, and very interesting projects (Fig. 70). The scope of shapes and sizes and the variety of surface decorations are virtually unlimited. Plastic materials—because of their wonderful

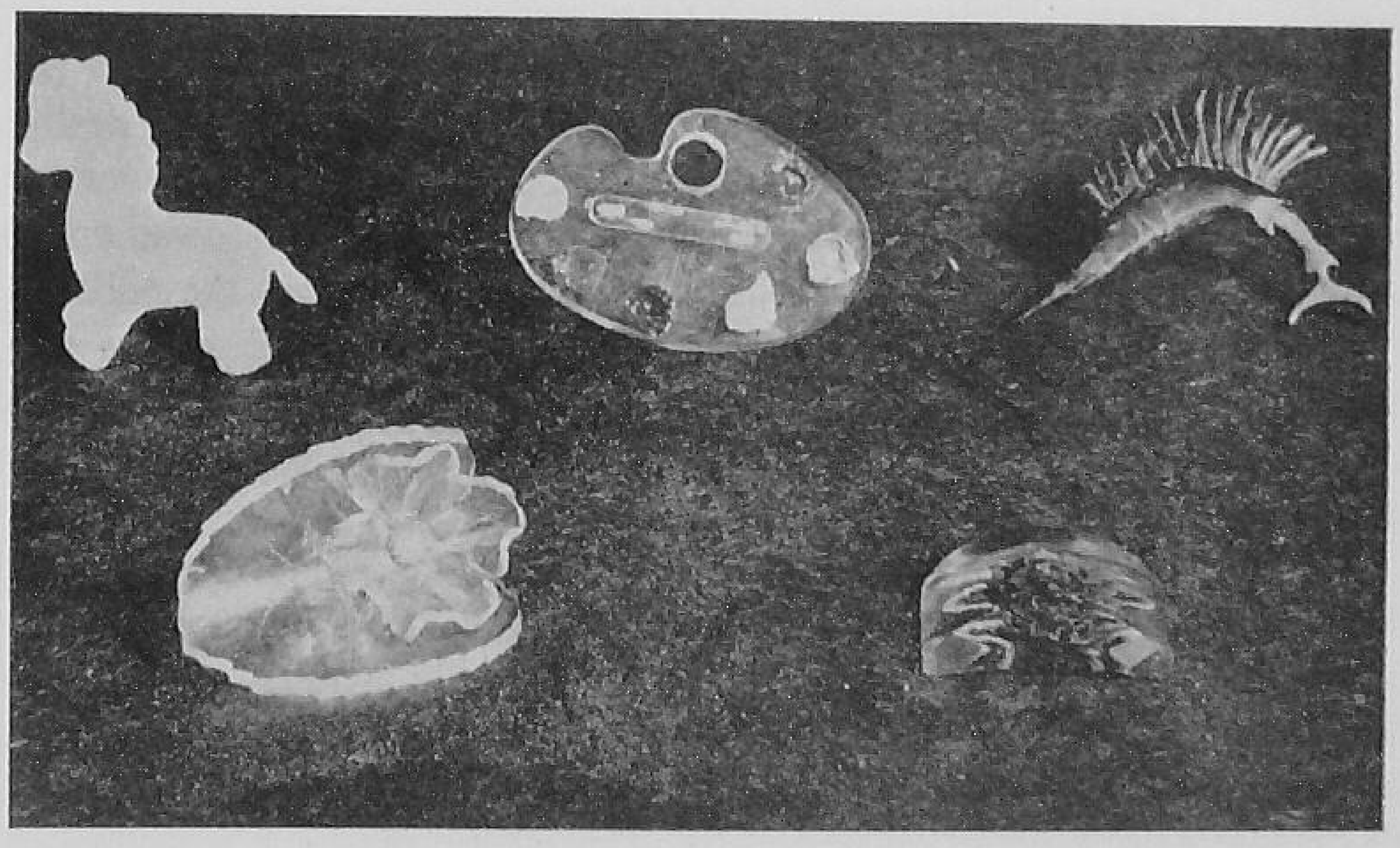


FIG. 70. Typical plastic pins.

surface finish, color, and workability—provide ideal substances from which to create pins according to individual ideas and tastes.

The pin in the top left-hand corner of Fig. 70 was made from $\frac{3}{16}''$ thick white Catalin. The design was merely sawed on the scroll saw and the edges were sanded and polished.

The miniature palette in the center was made from $\frac{1}{8}''$ cellulose acetate by an art student. The outline and hole were sawed on the scroll saw and the holes for the paint splotches were hollowed out with burrs, using a

flexible-shaft hand-motor tool. The various colors for the splotches were obtained by using colored lacquers.

In the upper right-hand corner is a fish made from mottled Bakelite. This fairly intricate design contains many sharp points and comparatively weak sections. In this case, to avoid breakage the design was drawn on a piece of flat sheet larger than the minimum measurements of the fish. The object and the forming was done by removing (carving) material with the hand-motor tool before the outline was sawed on the scroll saw. Most of the polishing of the top surface was done with the hand-motor tool buffs before the outlines were sawed. It would be hazardous for a beginner to polish such a comparatively fragile project on the regular power buffs. The slender sections and the points would be likely to be deformed or broken. This type of project calls for careful, patient craftsmanship but is not at all beyond the capabilities of the average beginner.

In the lower left-hand corner a pin is shown that has been made primarily by forming sheet plastic material (thermoplastic) into the desired shapes. Any thermoplastic material may be used, such as cellulose acetate, Plexiglas, etc. The outlines of the flower and back piece were sawed on the scroll saw and the designs carved into the flat surfaces. Next the polishing of the edges was accomplished on the power buff. The pieces were then heated in an appropriate oven to the required temperature and formed by hand to the desired shape. The flower and pin-back were then cemented into place.

The pin shown in the lower left-hand corner was made by carving a flower internally into a piece of Plexiglas. The Plexiglas blank was sawed on the band saw from ¾″ sheet stock and carefully sanded on the power belt sander. The plastic was polished on the power buff to a high surface luster, after which the internal carving was done. Directions for this type of carving will be found on page 796. The plastic pin-back was then cemented into place.

The materials used in making pins need not in any sense be specially selected plastics. The scrap pieces and left-over sheet stock that normally accumulate from the fabrication of larger projects may be used to good advantage. The manufacturers of commercial plastic objects often offer scrap stock for sale at reduced prices. If you intend to do forming operations you must be sure that the available stock is of the thermoplastic variety. A simple test is to immerse a sample piece of the material in boiling water for 2 to 3 minutes. If the material then bends easily it is certainly thermoplastic. Of course, Lucite and Plexiglas require a temperature

higher than that of boiling water to make them easily formable. However, the boiling water test will lead you in the right direction because even those plastics that actually soften at higher temperatures will show indications of softening in boiling water. For a more detailed description of forming operations, see Process No. 14.

General Procedure for Making Plastic Pins

While it is not possible to provide all the detailed information necessary to make any type pin, yet it is quite helpful to have a general procedure which covers the major steps for this class of projects. If the following procedure steps are carefully followed, no trouble should be experienced in obtaining satisfactory results:

1. *Choose a suitable design.* You may seek your design from among the many which are available in design books or art type periodicals. Far better, from the point of view of personal satisfaction, you should create your own design. Draw a freehand sketch as near as you can to the exact shape and size or cut out pieces of stiff paper or cardboard to represent the plastic pieces that are to go into the pin. It is most important that you have a very clear idea of what you wish to produce. A good craftsman always works from a well-conceived plan, either from drawing on paper, models, or from carefully thought-out plans fixed in his mind.

2. *Lay out design lines on the plastic pieces.* Complete instructions for layout operations will be found in Process No. 2. Be sure not to mar the surface of your stock by unnecessary lines or scratches. Work on some sort of a soft firm pad to protect the surfaces. Be sure to make very light design lines.

3. *Saw just outside of the design lines.* Beginners often make the mistake of sawing in the middle of a design line. This practice is bad because after the sawing is completed the line is obliterated. The design lines should remain until the final sanding operation to make sure the size and shape originally decided upon are maintained. On designs that involve circles or regular curves a slight deviation from the design lines will change the entire effect desired. Small radius curves are sawed by hand with a jeweler's saw (Process No. 5) or on the scroll saw (Process No. 26). The band saw (Process No. 25) is most satisfactory for large radius circles and straight lines.

4. *File away the saw marks.* Most saws leave a rather rough, jagged surface that is removed most easily by using a medium-cut file (See page 764). Be sure to protect the plastic surfaces between soft protective jaws

if you hold your work in a vise while filing. Also be sure not to allow the file teeth to come into contact with any surface other than the one being filed. File almost to the design lines leaving only very little for the sanding operation. In some cases the filing may be omitted. If the saw marks are not too deep and if a good belt or disk sander (Process No. 28) is available, the filing is usually unnecessary.

5. *Test the piece for conformity to original design.* It is good practice to check at this point to ascertain if you have accomplished the desired end. Check your work with respect to design lines by comparing the piece you have produced to the original plans. Check for squareness of corners and planeness of surfaces.

6. *Sand surfaces.* Sanding operations are described in Process No. 8. Wherever possible the power sander should be used to cut down the time and work involved. It is important that the final sanding with very fine abrasive paper (wet or dry) be done carefully to insure a surface that may be easily polished. The eager beginner very often fails to remove, by sanding, scratches that show up later on the final surface. He then attempts to remove these scratches during the polishing operation. This practice leads to excessive pressure and consequent burning or discoloration of the polished surface. A thorough sanding will save time in the overall finishing process.

7. *Buff and then polish to a high luster.* Refer to Process No. 9 and No. 10. Be sure that the wheels (buffs) are not rough or clogged with old abrasive powders. It is always good practice to make a trial run on a scrap piece to determine how the wheel and abrasive are going to work. Do not press too hard and be sure to keep the piece being polished in constant motion with respect to the face of the buff. This practice will minimize the lines that would result from the buff threads or from hard particles which attach themselves to the threads during the buffing process. Obtain the highest possible surface luster and thereafter keep the pieces wrapped in soft cloth until ready for assembly.

8. *Assemble all parts.* In general, all parts are polished before being assembled because unpolished surfaces will produce unsightly joints. The pieces to be assembled are usually cemented together. For the proper cements and cementing techniques, see Process No. 12.

9. *Attach pin-back.* Pin-backs with a plastic bar, such as those shown on page 750, are the easiest type to attach. All that is necessary is to clean the surfaces and apply enough cement to insure a good strong joint. Provision should be made for keeping the pieces stationary until the cement

has a chance to harden. In case you prefer to use the metallic type pin-back, it can be attached by cementing or held in place with drive nails (refer to page 806).

Favors and Specialties

This type of project has almost endless possibilities. The beginner in plastic work may make use of his talents to create a great variety of interesting and original objects at a minimum of time and expense. Favors,

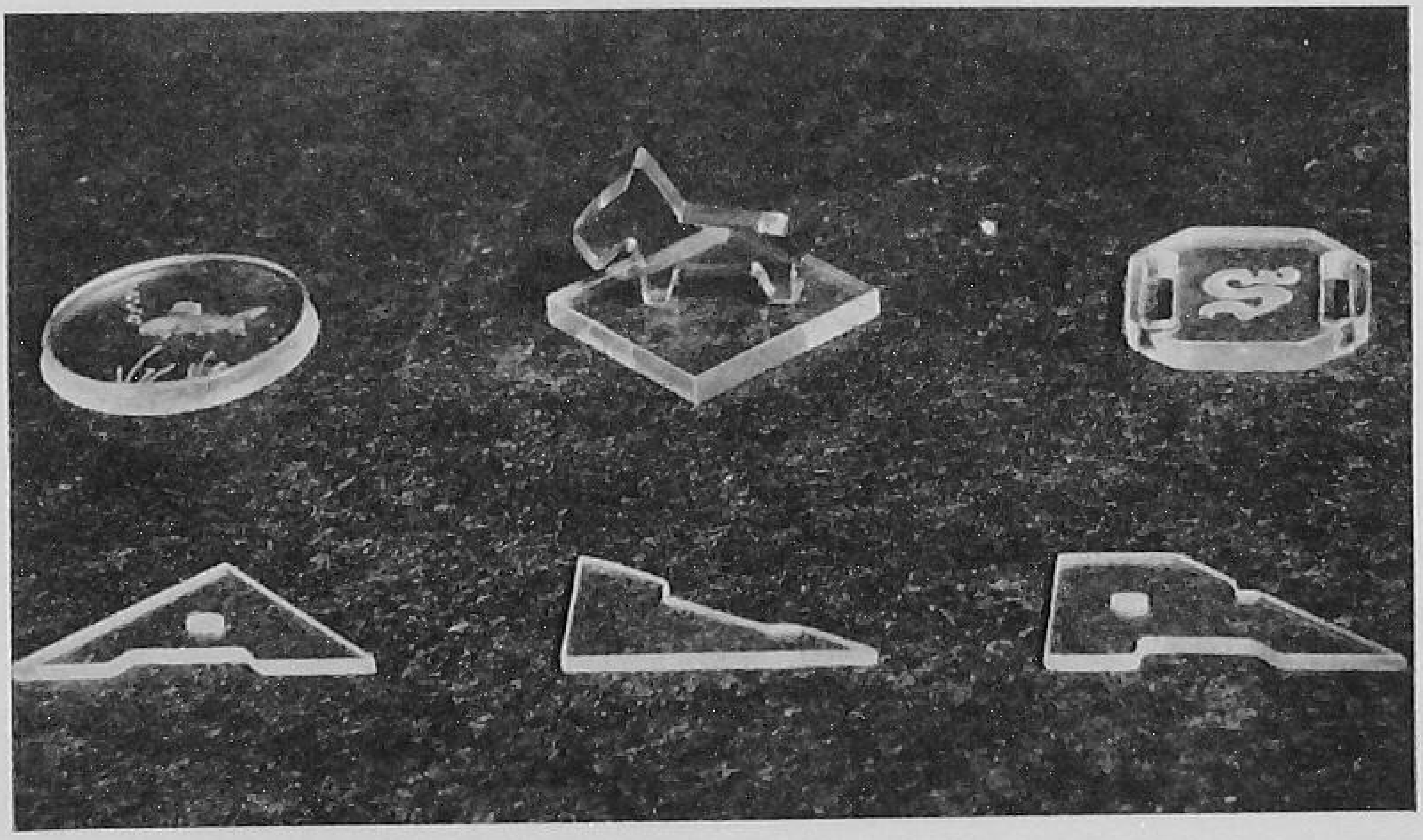


Fig. 71. Favors and specialties.

place name signs, ornaments, decorations for seasonal or personal parties, Christmas gifts, small wearing apparel accessories, and a great many other useful articles are possible with a little effort in planning and fabrication. For other suggestions along this line, see page 127. An ambitious host or hostess can make personalized favors for a party of twelve or more in much less time than it would have taken his or her mother to cook all the party food.

The objects shown in Fig. 71 are typical of the many that have been turned out in almost mass production style in the author's craft class. The object in the upper row left was used as a favor at a sea food dinner. The little scotty was used as a paper weight to hold place name cards at an outdoor dinner party. The belt buckle could be used as a personalized

initialed favor by tying it with a gay ribbon to the napkins. The initials in the foreground could be used in lieu of place name cards.

Procedure

The procedure for making these articles follows very closely the procedure used in making any other small plastic object, except that, wherever possible, mass production methods should be incorporated. The like processes for each of a number of like objects should be done at once. For instance, the laying out of the outlines for all the pieces should be done at one time rather than individually; the sawing should be done for all pieces at once; etc. It is a good practice to make templates to help in drawing the design lines. Also it is often possible to make special holding devices (jigs) or other supports for drilling, sawing, filing, sanding, and cementing.

Salad Set

The salad set shown in Fig. 72 is typical of the type of work that can be done by a beginner in plastic crafts. It is neither the best nor the worst of the many salad sets that have been made in the author's craft classes. This one was made from Plexiglas sheet. Plexiglas was chosen because, although it is a thermoplastic material, it has a comparatively high softening temperature and consequently will be affected little by hot water. The

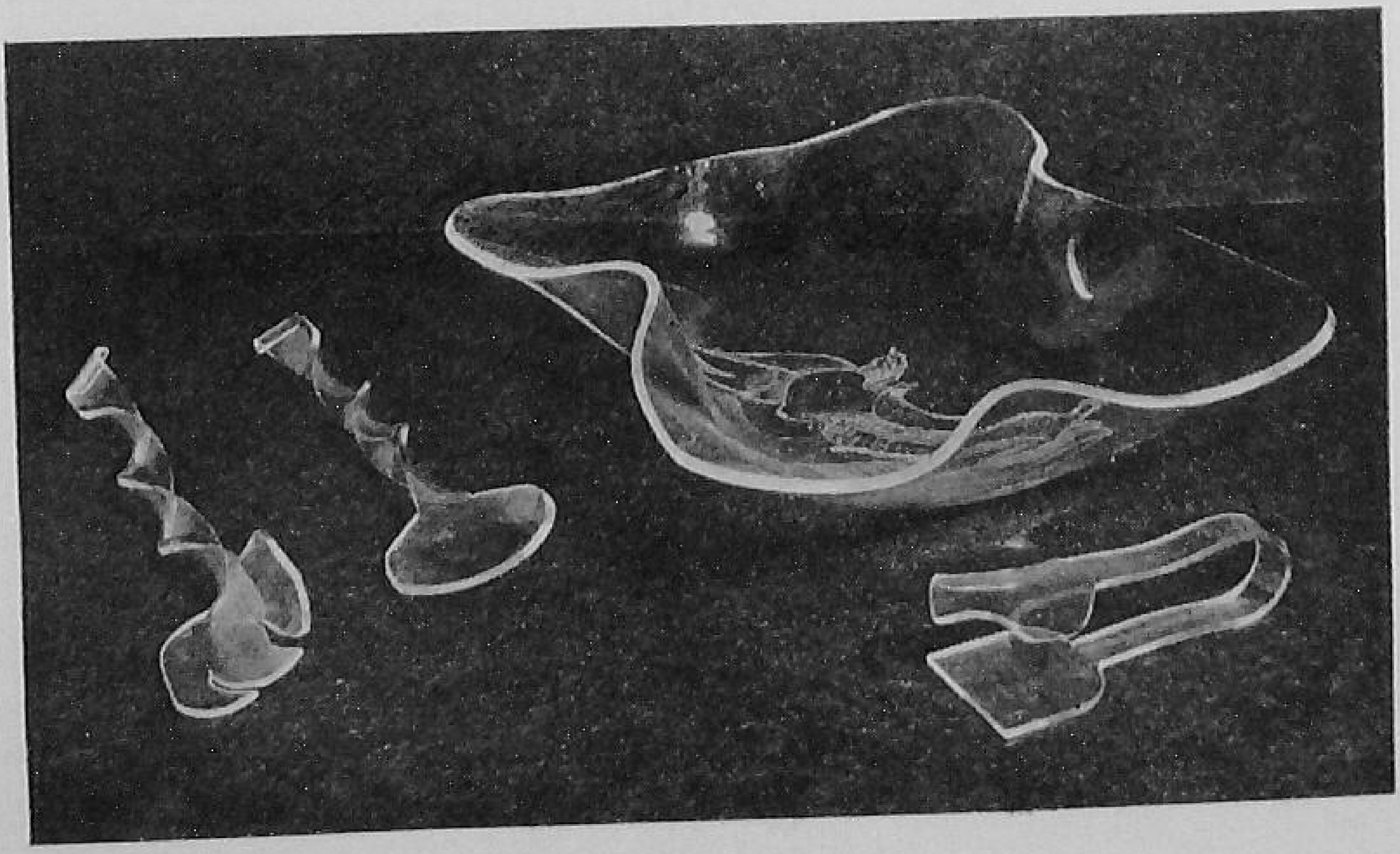


FIG. 72. Salad set.

size and shape of the pieces may differ somewhat according to the intended use and personal taste. Also the type of surface decoration is determined by personal desires and originality.

Procedure

1. The salad bowl shown in Fig. 72 was made from $\frac{3}{16}''$ Plexiglas sheet. In planning the size and shape of the bowl it is helpful to cut a flat paper pattern to the approximate size and shape that you think will be adequate for a bowl. Try bending the paper pattern into the shape you want the bowl to assume and then, if necessary, trim the pattern to obtain the desired results. The shape of the finished bowl will greatly influence the bending procedure followed. If an absolutely regular concave bowl were desired, it would be necessary to make very special forming apparatus, which would be far too complicated for the beginner. The type of bending illustrated by the bowl in Fig. 72 is comparatively easy to do entirely by hand. Be sure that you do not try to obtain formed surfaces that are too complicated. Much difficulty will be encountered in holding the bent portions in the desired position during the forming operations. When the pattern has been trimmed to the required size and shape it may be used to lay out the outline on the masking cover of the Plexiglas sheet. The bowl piece is then sawed on the band saw and the edges filed, sanded, and polished, before removing the masking covering.

2. The next step is to choose the design that is to be engraved or carved into the bottom surface of the bowl. The design should be carefully drawn on tracing paper on the bottom of the bowl piece (Process No. 4). Remember that the design will be reversed when finally viewed from the top surface—that is, it will appear as a picture viewed from the wrong side. Consequently, the tracing paper should be reversed before the tracing is done, particularly if the design contains lettering.

3. Scribe the design lines through the masking paper or use very small scriber point marks to locate the design lines. Then carefully remove only as little of the masking paper as will allow you to work on your design lines with the engraving or carving tools.

4. Engrave or carve the design (refer to Process No. 13 for engraving and Process No. 18 for carving). Be sure not to carve deep enough to pierce the top surface.

5. Color the design lines if desired. This technique is described in Process No. 15.

6. The forming process is next. The Plexiglas must be heated in a suit-

able oven to a temperature of about 250° F. (Process No. 14). While the piece is heating, collect all the necessary forming accessories. Two pairs of cotton gloves should be worn for easy handling of the hot plastic. A soft cloth pad should be provided upon which to hold the sheet during the forming processes. Be sure that you have the desired shape well in mind. The actual forming is easy. Just remove the sheet from the oven (wearing the two pairs of gloves—one over the other). Place it on the soft pad and hold the center down with one hand protecting the plastic surface with another soft pad. Raise the edges where desired. It is well to make a flat portion in the center so that the bowl will not rock while in use. Hold the raised edges at the desired position and keep them in that position until the Plexiglas cools enough to start hardening. As the temperature decreases the material will get more and more firm and the final adjustment in shape will be made just before the final hardening takes place. If the desired form is not realized in the first attempt, the sheet may be reheated. Upon reheating the raised portions will revert to the original flat form. This process may be repeated as many times as is necessary to obtain the desired result.

7. Check all surfaces for scratches and repolish wherever necessary. Do not attempt to polish the colored engraved or carved designs with an abrasive. A soft clean buff without any abrasive must be used for this purpose; otherwise the design lines will be filled with the tallow and abrasive material.

8. The spoon, fork, and tongs are next. Cut out paper patterns for each article. Remember that the spoon and fork handles are shortened considerably with twisting. Consequently the patterns must be lengthened somewhat to compensate for this effect. The exact amount depends upon the number and tightness of the twists and cannot be determined accurately without an actual trial with a scrap piece.

9. After the patterns are made, lay out the shapes on the masked Plexiglas sheet (Process No. 2).

10. Cut the outlines on the band saw (Process No. 25).

11. File and sand the sawed edges (Process No. 6 and No. 8).

12. Polish all surfaces (Process No. 10).

13. Heat and twist the fork and spoon handles. The twisting is accomplished by holding one end of the hot strip in the vise (between soft protective jaws) and twisting the other end. Wear two pairs of cotton gloves while twisting and rub the twisted surfaces with the fingers to keep them regular. After twisting the handle, the end held in the vise is bent

to the desired angle. It is usually possible to form the large end of the fork and spoon while the cooling is taking place. Mold the ends smoothly and evenly with the gloved fingers to the desired concave shape. If the material gets cool too quickly it may be reheated easily. If it is necessary to again place the entire article in the oven after the twisting has been done, the twisted portions should be wrapped with several layers of wet cloth to prevent them from untwisting while in the oven.

14. Check all surfaces for scratches and repolish if necessary (Process No. 10).

Cigarette Box

Boxes of this type are usually made rectangular in shape because this makes the pieces that go into them comparatively easy to make and to fit

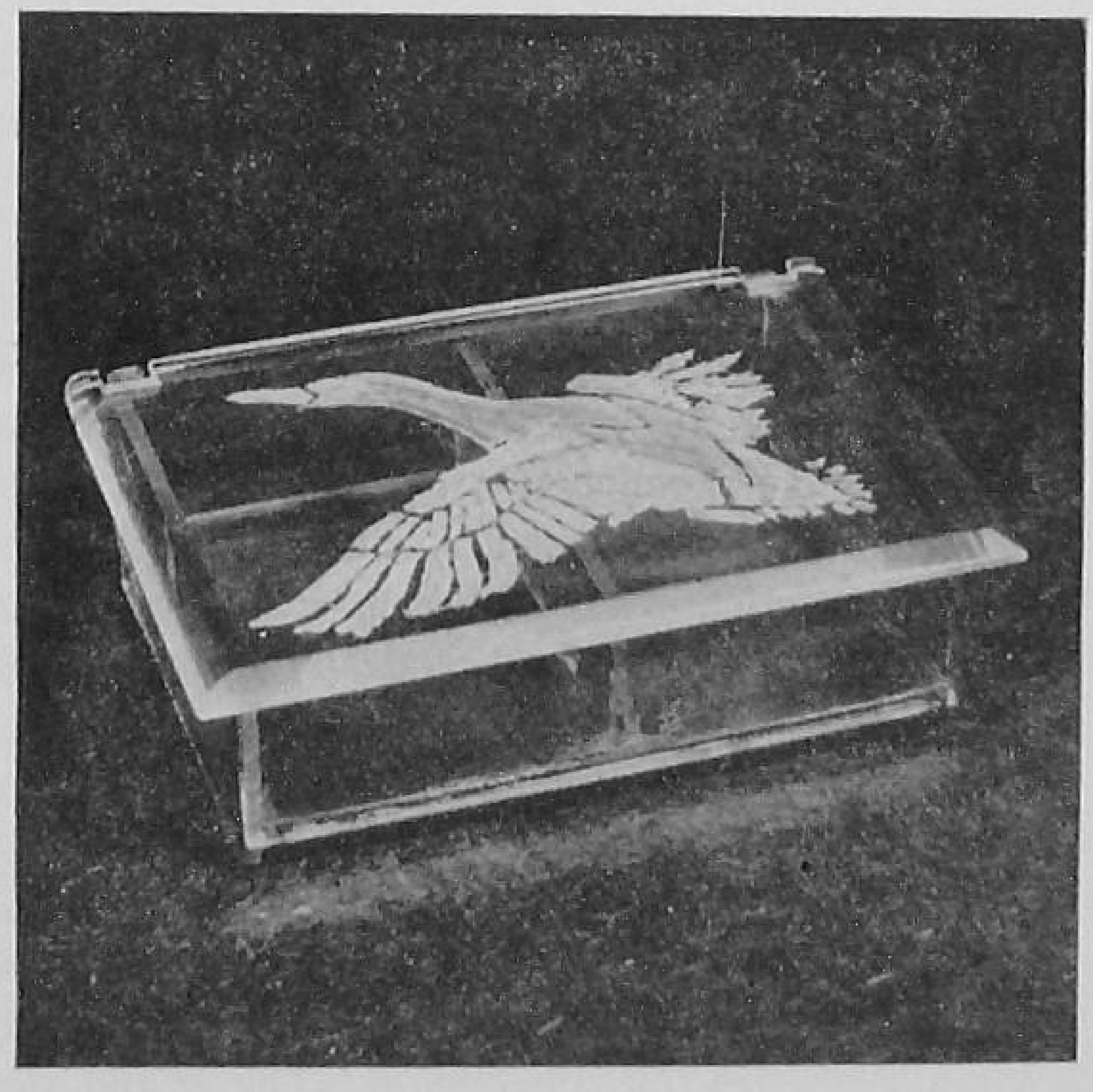


FIG. 73. Cigarette box.

together. The construction of boxes, which involves the assembly of many small components, calls for careful workmanship in preparing the individual pieces. Probably the most difficult part of this job is to obtain good fitting joints. No matter how much time is spent in ornamentation or polishing, the appearance of the box will always suffer if the joints are

poor. The covers of such boxes lend themselves admirably to ornamentation by various methods. For a carved cover it is well to use Plexiglas because of its superior optical properties.

Procedure

1. Decide upon the exact shape and size of the box and cover. The box shown in Fig. 73 has two compartments, each of which will hold two packages of cigarettes. The inside dimensions of the compartments are $3\frac{1}{2} \times 3\frac{1}{2} \times 1''$. In planning the over-all dimensions, allowance must be made for the thickness of the constructional material. The box shown is constructed of $\frac{1}{8}''$ sheet. Consequently the total length will be $7\frac{3}{8}''$ and the width will be $3\frac{3}{4}''$. Draw a plan of the bottom of the box to show the details of the joints to be made in the wall pieces. This will give the correct size for the bottom piece and also the length of each wall piece. The height of the wall pieces will be greater than the actual depth of the box by the thickness of the plastic sheet. Usually $\frac{1}{8}''$ sheet stock is used for the bottom and sides and a thicker piece for the cover. The method of fastening the cover will influence the dimensions of the back piece. The box shown has small tabs left on the top of the back piece and recesses have been cut into the cover so that pins may be fitted for use as hinges. In this case when the cover closes down it rests flat on the top of the wall pieces. Covers that are not hinged are commonly provided with inside guide pieces cemented to the bottom of the cover which fit down into the top corners of the box. It is a good practice to make a scale drawing or to cut out patterns for each individual piece used. Practically any available material may be used. Catalin, Bakelite, cellulose acetate, Plexiglas, etc., will serve because no forming operations are involved. Many different colors and color combinations can be utilized as desired.
2. Lay out the individual pieces on the plastic sheet to be used. If Plexiglas is chosen the layout lines will be drawn on the masking paper cover. Layouts must be skillfully and accurately drawn with a good straight edge and a sharpened pencil or scriber. The fit and appearance of the joints will depend greatly upon the accuracy of these outlines.
3. Saw out the pieces on the band saw, keeping just slightly outside the layout lines (Process No. 25). Be sure to leave the hinge tabs on the back piece.
4. File away the saw marks with a medium cut file. Test the piece for squareness and trueness as the filing process progresses.
5. Use the power sand belt to finish the filed edges, first with a coarse

and then with a fine abrasive belt. Again check for squareness and trueness. At this point be sure that pieces that are supposed to be alike in length actually are; otherwise poor joints will result. Sand all work surfaces with very fine (wet or dry) sand paper (Process No. 8).

6. Buff and polish each piece to a high luster, being careful not to mar the joint surfaces.

7. The next step is to cement the pieces together. There are several methods that give good results. One method is to make two wooden blocks that are exactly the size of the inside of the two compartments. The pieces are assembled around these blocks and held in place with elastic bands or pieces of string while the cementing is being accomplished. The corners of the blocks should be slightly cut away so that the cement will not run on to the wood. (Refer to Process No. 12 for cementing instructions.) Another method of holding the pieces in place during assembly is to nail small wooden strips to a board so that the strips form a boundary into which the pieces fit accurately. The strip should not extend out to the corners of the box; otherwise they will interfere during the cementing process.

8. The cover of the box in Fig. 73 was made from 1/4″ Plexiglas. Be sure to leave the masking cover in place as long as possible. The edges are chamfered to an angle of about 45 degrees to take advantage of the internal reflection (refer to page 739). The recesses in the back tab of the cover must be cut in deep enough to allow the cover to open without binding on the back piece tabs. The holes for the hinge pins must be drilled in the cover first. A piece of brass or German silver about 1/16″ in diameter will be just about right for the pins. Be sure that the holes in the cover are of a size that will insure a tight fit for the pins. This means that trial holes using number-size drills should be drilled in a scrap piece until the desired fit for the pin is obtained. After the holes in the cover have been completed, clamp the cover in place and drill the tab holes as guides for the drill. Use the same size drill as you used for the cover holes. The holes through the tabs should then be enlarged slightly so that the hinges will not bind.

9. Ornament the cover as desired. The design shown in Fig. 73 is carved from the bottom surface of the cover. Choose a design and draw it carefully on tracing paper. This design is then transferred from the tracing paper to the masking paper on the bottom of the cover. Remember that it is necessary to reverse the design when the transfer is made (refer to page 760). The positions for the various holes which will be made during the carving process are easily located by a slight prick punch mark through

the masking paper. Remove the masking paper and hold the tracing paper design under the block to check the design position. Carve the design using the hand-motor tool carving kit (refer to Process No. 18 for detailed directions). Polish the cover and fasten in place with the hinge pins.

Photograph Frame

There is a great variety of photograph frames that can be made from sheet plastic material. The one shown in Fig. 74 was made from 1/8″

FIG. 74. Photograph frame.

Plexiglas. It is probably one of the most simple yet effective frames that has been devised. Use has been made of snow crystal patterns to provide a simple but dainty ornamentation. Of course, the dimensions of the picture space may be varied in accordance with the size of the picture to be framed. The one shown is about 7″ x 8″ exclusive of the curved portions. Plexiglas was chosen as the material because it is thermoplastic and also because it has an exclusive property of enhancing the naturalness of objects that are viewed through a layer of it.

Procedure

1. Make a full-size plan of one section of the frame. Decide upon the type and extent of the bend. Locate the holes.
2. Lay out two such pieces on the masking paper cover of the Plexiglas. Locate the four holes on only one of these sections.
3. Saw the pieces on the band saw (Process No. 25).
4. File the edges to remove the band saw marks (Process No. 6).
5. Sand the edges on a power belt sander (Process No. 28).
6. Polish on the power buff (Process No. 10).
7. Locate the four holes by pressing the point of a scriber into the plastic sheet. At this point you must decide upon the size of the machine screw that is to hold the two pieces together. For this size project a #6 machine screw about $\frac{3}{8}''$ long will serve. The holes which are to be drilled into the front piece will be larger than those which will hold the threads on the back piece (Process No. 17). Drill the four holes in the front piece. One-eighth inch in diameter will be just about right.
8. Lay out and engrave the snow crystal designs (Process No. 13).
9. The next step is to obtain the bends in the two pieces. The most simple bend is that of a circular character. The easiest way to do this is to find a cylindrical object that will serve as a mandrel over which the bend may be made. A piece of 1″ dowel will be right for this bend. One end of the dowel should be held in the vise. The pieces are removed from the oven and quickly bent over the face end of the dowel.
10. Heat the pieces in the oven until they are soft enough for bending. Wear two pairs of cotton gloves to remove the pieces and bend them over the dowel held in the vise. Hold the pieces in the bent shape until the Plexiglas cools.
11. Hold the two pieces of the frame together and locate the holes in the back piece. Drill $\frac{3}{32}''$ holes and tap them for a 6–32 machine screw (Process No. 21).
12. Insert the picture between the two pieces and screw them together with the machine screws.

Carved Pin and Earring Sets

This project is very popular with beginners in plastic craft work. The reason is simple. A beautiful and satisfactory project can be produced with a minimum of work and skill. The metal used is Lucite or Plexiglas because of its favorable optical properties. The flower designs are inter-

nally carved from the back side. With proper coloring techniques the result is surprisingly natural. Although the sets shown in Fig. 75 are rectangular in shape, no limitations in shape or size exist.

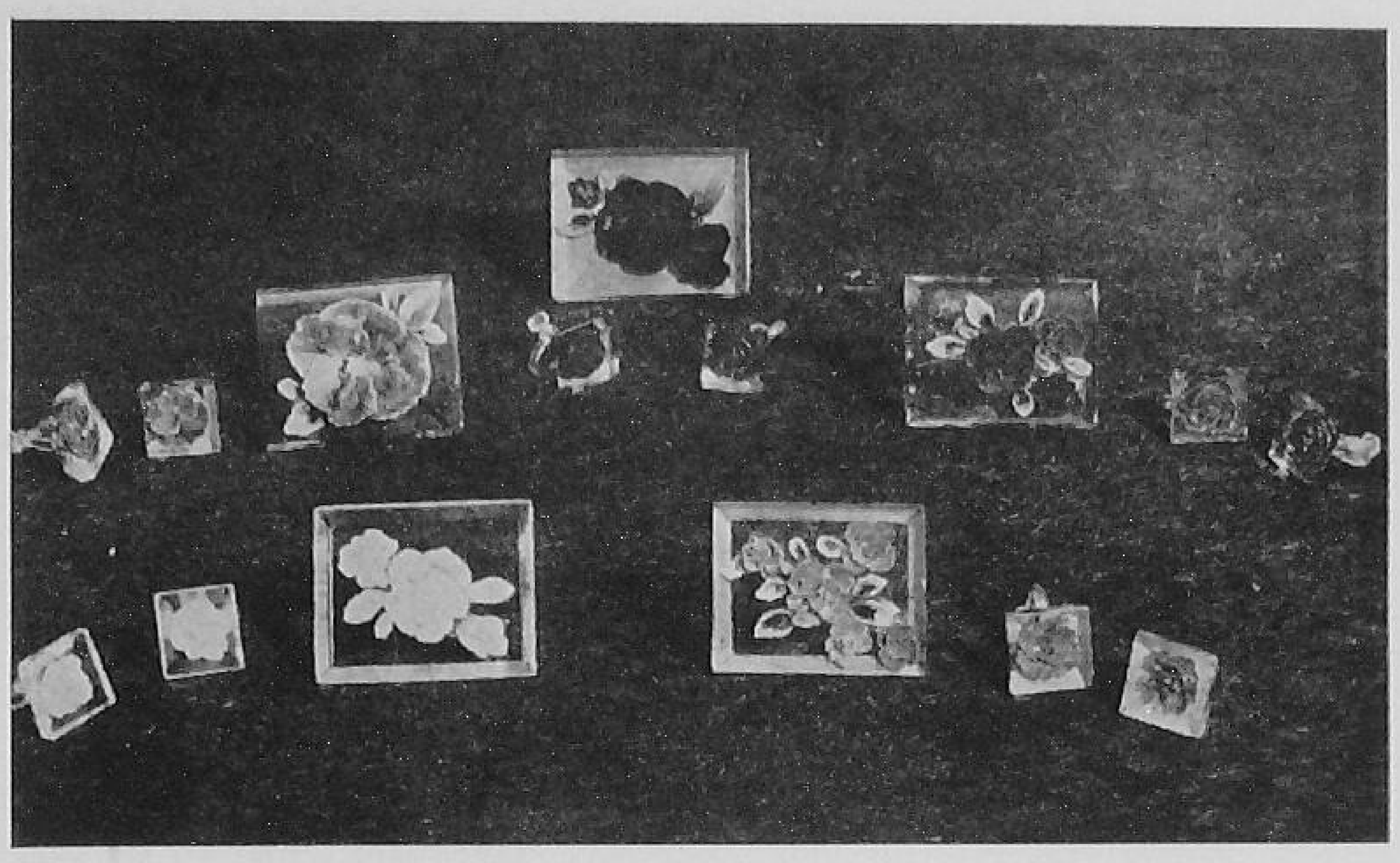


FIG. 75. Carved pin and earring sets. (*Courtesy of Paul Malek, Instructor in Education, New York University*).

Procedure

1. Choose a size and shape for your set and then decide on the subject to be carved into the pieces. It is a good practice to make a full-size drawing of the pieces with the carved design drawn in two dimensions so that the size and position of the flower design may be determined with respect to the plastic pieces.

2. Lay out the outlines of the pieces on the paper covering of the plastic sheet (Process No. 2).

3. Cut the pieces outside the layout lines on the band saw (Process No. 25). If some of the pieces are too small to allow use of the band saw then it will be necessary to saw them by one of the many hand saws available (Process No. 5). Check for squareness of corners with a try square or machinist's square.

4. File away the saw marks (Process No. 6).

5. Bevel the edges of the pieces to an angle of about 45 degrees. This angle is advantageous because of the spectacular internal reflecting power of this type of plastic.

6. Sand the pieces with both coarse and fine abrasives on the sand belt or the sanding disk (Process No. 28). If the sanding machine has an adjustable stop or rest, the bevels can be evenly sanded by its use. Finish by hand with very fine (wet or dry) sandpaper.

7. Buff and polish all surfaces (Processes No. 9 and No. 10).

8. Carve in the flower designs. For a full description of this carving technique, see Process No. 18.

9. Slightly tint the bevel portions with any color desired for a rich color effect. This can be done by wiping a small amount of dye across the surface of the bevels. If the dye flows to any other part of the plastic piece it may easily be buffed away. Be sure not to use too much dye and be sure not to leave it on too long.

10. Attach the earring backs. The backs are supplied with a plastic surface that is easily cemented to the earring plastic backs. However, be sure that the surfaces are clean before cementing, and then be sure to let the cement set long enough to harden properly (Process No. 12).

Carved Paper Weights

Many beautiful and useful objects can be made from thick sheet plastic material. Those shown in Fig. 76 were made from ¾″ Plexiglas sheet

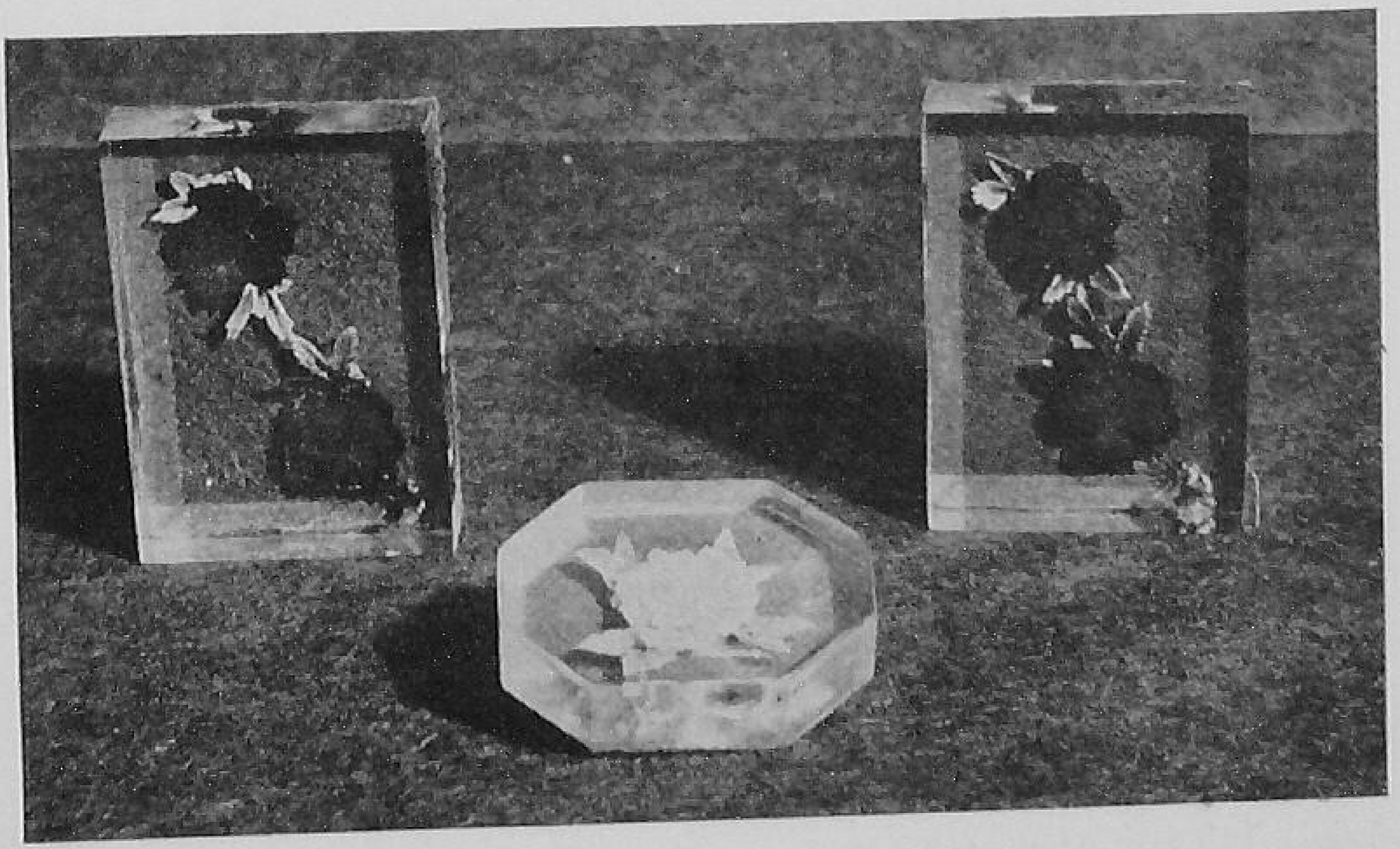


Fig. 76. Carved paper weights. (*Courtesy of Paul Malek, Instructor in Education, New York University*).

stock. The decorative flower designs are good examples of internal carving that can be produced by beginners in plastic craft. The paper weight shown in Fig. 77 was made from a cube of Plexiglas 2″ on each side. The four corners of the block were cut away to make an octagonal shaped figure, after which the flower design was internally carved from the bottom surface. Internal carving is a relatively new phase of decorative art which owes much of its popularity to the optical properties of the acrylic plastics

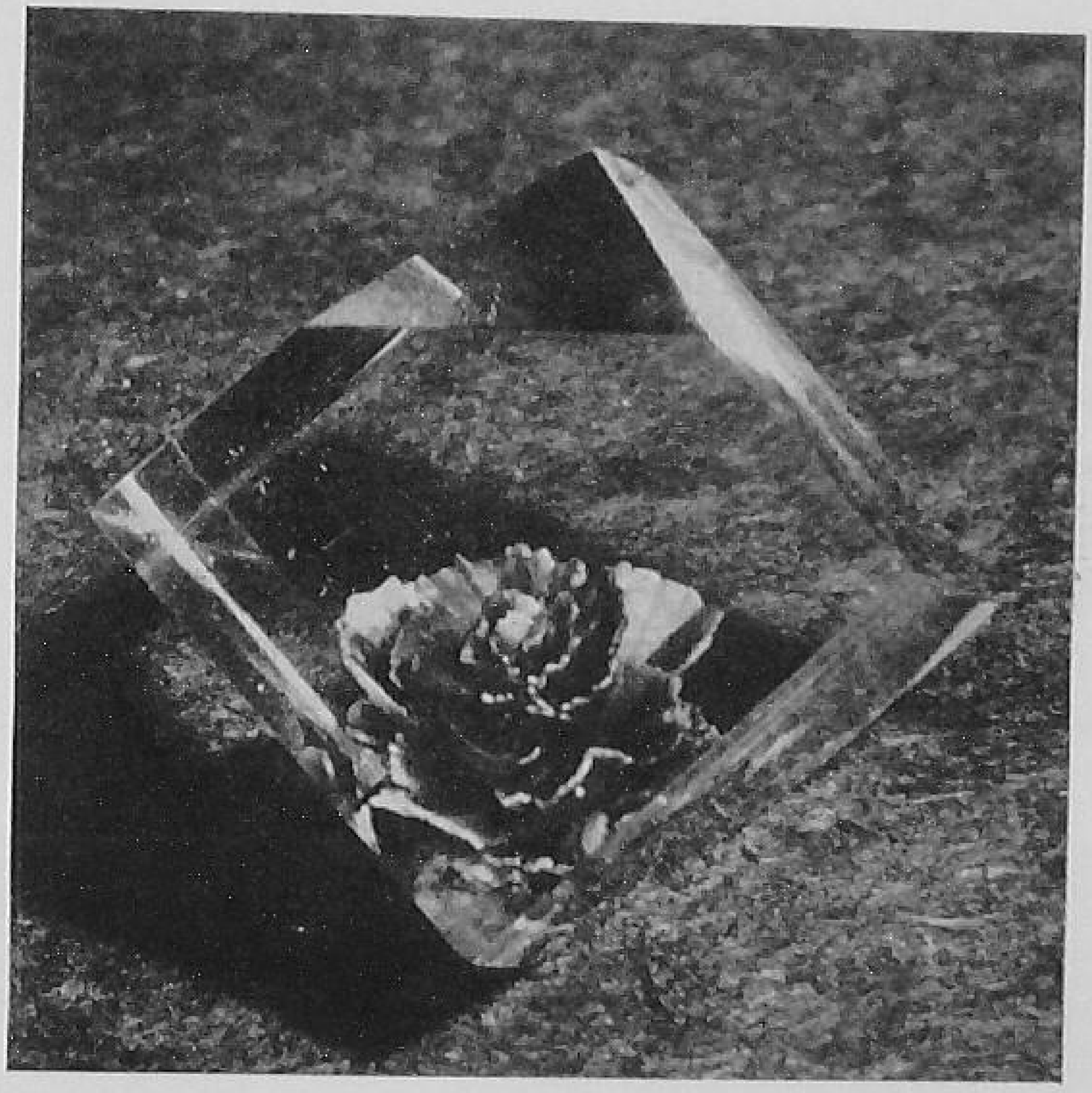


FIG. 77. Carved paper weight. (*Courtesy of Paul Malek, Instructor in Education, New York University*).

such as Lucite and Plexiglas. The actual carving process is not so difficult as one would imagine. With a little practice the average beginner will have no trouble in obtaining satisfactory results. (For a detailed explanation of this carving technique refer to Process No. 18.)

Procedure

1. Choose a size and shape for the plastic object you wish to make and draw a full-size plan of it. Paper weights are usually made with more or less compact shapes so that the weight of the object will be concentrated

on a comparatively small surface area. Practically any shape the craftsman desires will be acceptable. However, rectangular objects and those incorporating flat surfaces are by far the easiest to fabricate. Careful workmanship is necessary to produce regular or irregular curved surfaces.

2. Choose a design to be internally carved into the Plexiglas block. A fairly simple design should be selected by the beginner. The simplest figures, enhanced by the optical properties of Plexiglas, stand out as superior pieces of work. Draw the design on tracing paper and hold it on the plan of the block to be sure that the design and the block shape are harmonious.

3. Lay out the outline of the block on the Plexiglas masking paper with a sharp pencil (Process No. 2).

4. Saw out the block on the band saw, being sure to keep just outside of the outline lines (Process No. 25). When sawing thick sheet Plexiglas, the rate of feed must be very low. Use a fence or other rest, if available, for straight sawing and to help keep the resulting block square.

5. File the sawed surfaces until the saw marks are removed (Process No. 6). Do not remove the masking paper. Test the filed surfaces for squareness with a steel square and the corners with a try square or machinist's square.

6. Sand the filed surfaces on the belt sander using first a coarse and then a fine abrasive belt (Process No. 28). Check again for straightness and squareness and then finish the surfaces by sanding with very fine (wet or dry) abrasive (Process No. 8).

7. Buff and polish all edges to the highest possible luster (Processes No. 9 and No. 10).

8. Remove the masking paper and carve the design (Process No. 18).

Carved Bracelet

This type of ornamentation for a bracelet is very effective and not too difficult to render. The one shown in Fig. 78 has a rather intricate and striking internally carved flower design. The combination of internal carving and correct coloring technique gives these flower designs a lifelike appearance which is difficult to obtain by any other means. Although this is not the only method of ornamentation for this kind of a bracelet, it is certainly one of the most striking.

Fig. 78. Carved bracelet. (*Courtesy of Paul Malek, Instructor in Education, New York University*).

Procedure

1. Decide upon the dimensions for the bracelet length. The one shown was made from 3/8″ Plexiglas sheet. The actual length will, of course, depend upon who is to wear it. It is well to measure the wrist size with a piece of tape or string and then subtract about 1½″ so that the bracelet will be open enough to allow for easy use.

2. Lay out the outline on 3/8″ Plexiglas sheet (Process No. 2). The first outline will consist of a rectangular block of Plexiglas which will be cut and then further layout will be necessary.

3. Cut the rectangular block on the band saw (Process No. 25).

4. Lay out lines for the wedge shape of the bracelet ends. The middle portion should be left at full thickness for about 1½″.

5. Saw the bracelet to the wedge shape on the band saw.

6. File all sawed edges until the saw marks have been removed (Process No. 6).

7. Sand all filed surfaces on the belt sander (Process No. 28). For some types of designs it is not possible to use the belt sander for all surfaces.

In this case the sanding must be done by hand (Process No. 8). Finish the sanding process with very fine (wet or dry) sandpaper.

8. Polish all surfaces (Process No. 10).

9. Carve in the designs (Process No. 18). The carved designs must be carefully filled with plaster of Paris so that during the bending process the bracelet will not be distorted. If the cavities are completely filled and well packed, the bending process will not affect the shape of the carving.

10. Make a wooden mandrel the exact size and shape that you wish the inside of the bracelet to be. Smooth the surface with sandpaper.

11. Heat the bracelet in the oven to the correct temperature (Process No. 14). Be sure that the plastic is very flexible before trying to form it around the mandrel.

12. Bend the bracelet around the mandrel and hold it in position until hardening takes place.

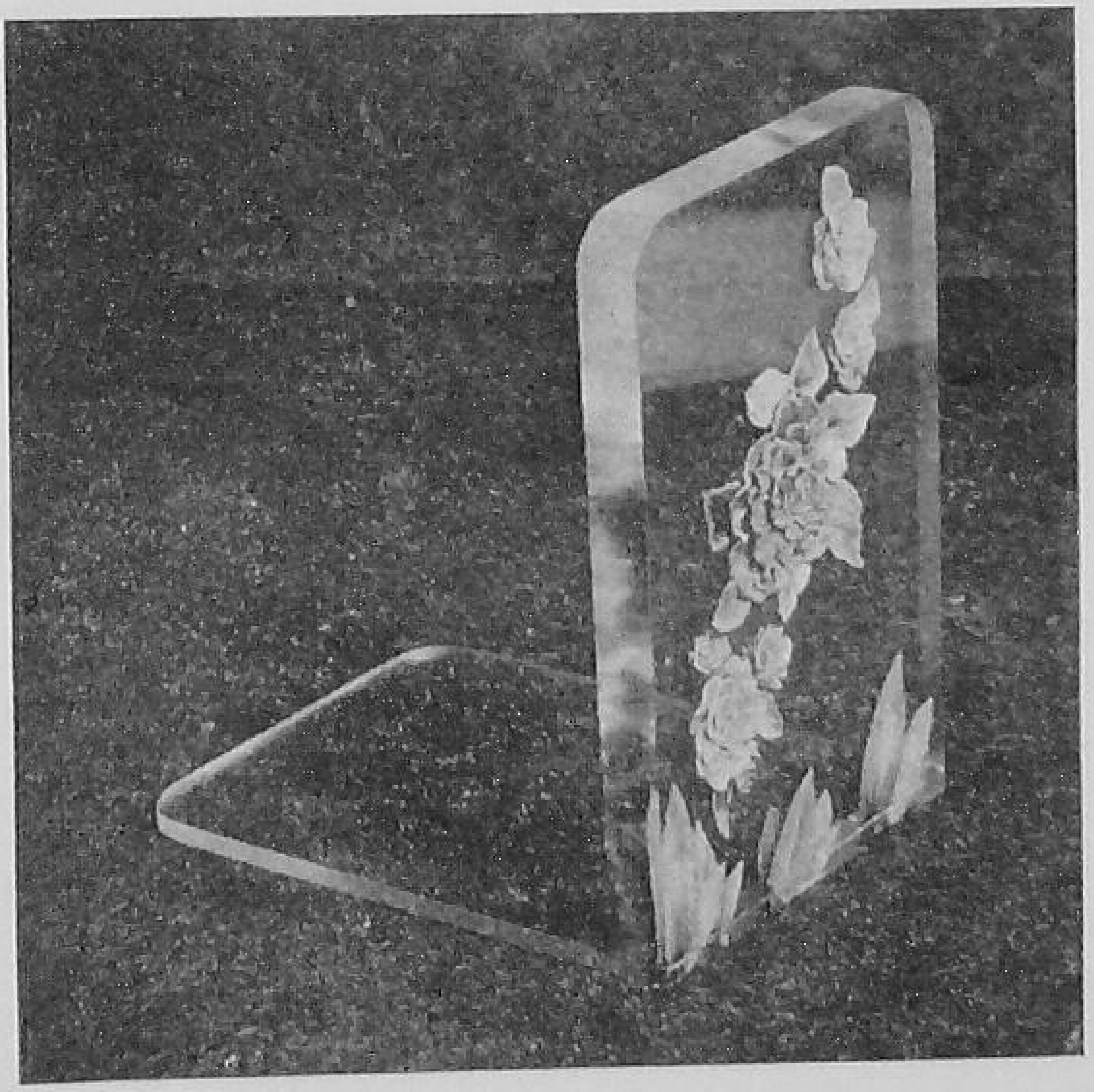


FIG. 79. Book-end with carved design. (*Courtesy of Paul Malek, Instructor in Education, New York University*).

Carved Book Ends

The book end shown in Fig. 79 was made entirely of Plexiglas. The base was fabricated from $\frac{3}{16}''$ sheet and the upright from $\frac{1}{2}''$ sheet. The

over-all dimensions, shape, and ornamentation of book ends depend greatly upon individual tastes. This one is 3¾″ wide, the upright 6″ high, and the base 5½″ long. The ornament in this case consists of beautifully carved flower designs. This type of carving is very effective in producing strikingly natural figures, especially when the coloring is carefully chosen and executed. It is evident that a carving, such as the one shown, could not have been done without adequate practice. However, it is very surprising how quickly the beginner can master this technique with a little perseverance. Many other types of ornamentation are possible. Monograms, silhouettes, engravings, and many other types of surface decoration are easily executed.

Procedure

1. Decide upon the shape, size, and design. It is well to cut out full-size paper patterns for each piece. Draw the design on tracing paper and lay it in place on the pattern to be sure that you obtain the desired effect (Process No. 2). The shape of the upright will, of course, be influenced by the size and type of the ornamental design chosen.
2. Lay out the pieces carefully on the masking cover of the plastic sheet.
3. Saw the piece on the band saw (Process No. 25). Saw with a steady slow pressure to avoid burning. Be sure to saw just outside the layout lines.
4. File the sawed edges using a medium-cut file (Process No. 6) and check them for squareness and trueness with a try square.
5. Sand the edges on the belt sander (Process No. 28) with a coarse and then with a fine abrasive belt. Finish sanding by hand with very fine sandpaper (Process No. 8).
6. Polish the edges on the power buffs (Process No. 10).
7. Carve or otherwise ornament the upright piece. If you decide upon a carved design, refer to Process No. 18 for detailed instruction. Notice that the leaf designs at the bottom of the book end in Fig. 79 were carved after the two pieces were cemented together. It is good practice to do all possible work on the upright piece before it is cemented to the base.
8. Cement the pieces together (Process No. 12).

List of Projects Suitable for the Craftsman

For Beginners

- Ash Tray
- Belt Hook
- Bill File
- Bottle Top
- Bracelet
- Cigar or Cigarette Holder
- Coaster
- Cookie Cutter
- Curtain Ring
- Curtain Tie-back
- Cut Flower Holder
- Dice
- Door Knob
- Drawer Pull or Knob
- Earrings
- House Numbers
- Key Ring
- Napkin Ring
- Nail File
- Nail Buffer
- Name Plate
- Paper Knife
- Paper Weight
- Pendant
- Poker Chips
- Shoe Horn
- Shade Pull
- Soap Dish
- Tie Rack
- Towel Rack
- Wall Plaque

For Advanced Workers

- Book Ends
- Cake Server
- Candlesticks
- Chess Set
- Cigarette Box
- Clock Case
- Clothes Brush Holder
- Costume Jewelry
- Cream Jar
- Cream and Sugar Set
- Desk Blotter
- Desk Set
- Door Knob
- Knife Rack
- Knife Handle
- Lamp
- Lamp Shade
- Mirror Case
- Necktie Rack
- Pen Set
- Picture Frame
- Place Mats
- Radio Case
- Salad Set
- Salt and Pepper Shakers
- Scissors Case
- Serving Tray
- Shower Curtain
- Sugar Scoop
- Table Ware
- Thermometer Stand
- Tissue Holder
- Trays

Basketry and Its Related Arts Section

BY

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INTRODUCTION TO BASKETRY AND ITS RELATED ARTS SECTION

This Section has been developed from the standpoint of the beginner in basketry work. The basic operations are explained step-by-step, with the aid of photographs that show the actual position of the hands in carrying out each process. All the pertinent information about the materials used is furnished right at the point where it is needed. Every effort has been made to answer the questions of the reader who may be working without the help of an experienced craftsman.

The first chapter gives a brief history of basketry, and an introduction to its more important terms. The second chapter describes and illustrates the materials and tools used in basketry, and explains their use. Many further practical directions for use by the beginner, including valuable hints drawn from the author's experience, are furnished in Chapter III. Each of the important wicker weaves is discussed in the fourth chapter, with detailed diagrams and photographs; and the equally complete fifth chapter explains how to make each kind of border used on woven reed articles. Chapter VI contains a most diversified group of projects in reed basket making. Each of them is arranged most effectively for ready application, with the pertinent information arranged under the headings of Materials Required, Tools Used and Complete Details of Procedure.

The materials, other than reeds, that are used in basketry form the subject of Chapter VII-X. These materials include cane, rush, raffia, synthetic straw braid, crepe paper, and others. In each case the uses and advantages of the material are fully described, the methods of working with it are explained and illustrated in step-by-step detail, and large numbers of interesting, useful projects are furnished, each complete with its bill of material, tools, and detailed procedure. Consistent emphasis has been placed upon the information most likely to assure success to the beginner in any projects he may undertake.

SOURCES OF MATERIALS

King & Walters, 27 Ferry Street, New York City. Chair cane, reeds, rattans, raffia, willows.

American Reedcraft Corporation, 83 Beekman Street, New York City. Basketry materials of all types.

Milton Bradley Company, 200 Fifth Avenue, New York City. Craft supplies of all types.

J. L. Hammett Company, 380 Jelliff Avenue, Newark, New Jersey. Basketry materials including colored waxed raffia.

Charles Schober, 307-309-311 North Second Street, Philadelphia, Pennsylvania. Basketry materials.

VII. BASKETRY AND ITS RELATED ARTS

Chapter I
BASKETRY

Chapter II
BASKETRY MATERIALS AND TOOLS

Chapter III
HINTS AND GENERAL INSTRUCTIONS

Chapter IV
WICKER WEAVES

Chapter V
REED BORDERS

Chapter VI
PROJECTS IN REED BASKET MAKING

Chapter VII
CANE AND ITS USES

Chapter VIII
PROJECTS IN CANE WEAVING

Chapter IX
RUSH AND ITS USES; PROJECTS

Chapter X
HONG KONG GRASS AND ITS USES; PROJECTS

Chapter I

BASKETRY

Among the crafts with a long and interesting history basket making takes a foremost place. There are few crafts more popular in America today than basketry. The work has been carried into the schools, the hospitals, and the clubs. Women are doing this type of work at home for both profit and pleasure.

Like weaving, basket making goes back to very early times but, unlike weaving, basketry has not come under the influence of modern machinery. It is the one craft in which the machine cannot replace the fingers. A sensitive hand is required to create, stitch by stitch, baskets exquisite in color, form, and design.

Basketry is the one craft, too, in which the civilized worker bows to the superiority of the primitive, who used with masterly skill the growing things everywhere about him.

History of Basketry

The crudest people of all ages have made baskets, using such materials as they had at hand. This utilization by primitive peoples of materials at hand constitutes, perhaps, not the least part of the charm of the craft of basketry. Every early folk knew well where to find an abundant supply of twigs and grasses; for they lived intimately with nature, and their home conveniences were made chiefly from vegetable materials. Nature supplied strong fibrous basketry materials among the vegetation of all countries. In the colder regions willow, split wood, rush, roots, bark, and grasses were found; in the warmer climates cane, bamboo, and the leaves and fibers of palm trees were available. All these were gathered by the deft-fingered natives and prepared with the aid of the teeth and the hands. Some were cut with sharp stones or shells. The pliable substances were woven into mats or baskets; or into sandals that protected the feet of the primitive people. Their girdles, the hats that shielded them from the sun, and their ornaments were plaited of rushes and straws, or the soft bark peeled from trees. Their huts or shelters, as well as the mats upon which

they slept, and the cradles in which they rocked their babies to sleep were of interwoven roots, twigs, and leaves.

Among certain tribes battle shields of flat woven materials were carried by the warriors. The traps set by primitive peoples for fish and game were also woven, of whatever materials were available. From roots and rushes the North American Indians wove seines with which to catch fish.

Many utensils used in the storage and cooking of foods were made of fibers sewed with a pointed bone for a bodkin, or woven so tightly that they needed no lining to be waterproof. To heat the water hot stones were dropped into these containers.

The Alaskans still make watertight baskets of split spruce roots. Baskets of rushes made by South Americans are woven so closely that they hold water.

Not only among primitive peoples was the craft of basket making developed, but also among the civilized nations of the ancient world this knowledge was used to advantage. The Bible tells us that the Israelites were commanded to offer as a sacrifice the first fruits of the land in a basket. Some baskets were made of gold and silver, but those used by the poorer classes were made of willow. The Bible tells us also about the basket of bulrushes, coated with mud, that served as a cradle for Moses. Baskets were connected with both Greek and Roman religious life: they were the receptacles for the offerings to the gods. Groves of willows were cultivated by the Romans to produce the materials used for weaving the wicker furniture and beautiful baskets used in the wealthy homes of the day. Baskets holding the kernels of grain and the loaves of Ancient Egyptian bakers show the same stitches as our modern weaves.

In China and Japan, baskets have been fashioned since time immemorial.

Long years ago the boats used by the Sumerians on the Tigris and the Euphrates rivers were made of wicker and either lined with pitch or covered with skins. Even today such basket-like boats are used on some of the smaller rivers in India.

In fact, we find that nearly everything needed, from the cradle to the grave, by the ancient peoples was made of basket work.

Legend claims that pottery had its beginning in an effort to make baskets watertight. A basket heavily lined with clay became the first cooking utensil. Repeated firings burned away the wicker exterior and a baked clay pot remained.

Contribution of American Indians

Basketry has come down to us more directly through the American Indian than through other peoples. It is to the Red Man that we are indebted for beauty and variety of design in this industry, for the Indian is the master artist of basketwork. He fashioned by weaving with the pliable materials of his environment—vines, twigs, grasses, split branches, and roots—various receptacles for transporting and storing goods. His hats, mats, snaring and fishing nets, ceremonial plaques, and even cooking utensils were hand woven.

Baskets containing articles required for the next world were put into the graves of the departed. For this purpose the Indian women saved their finest examples of the craft. Among the American Indians basket making was a woman's art. All their early legends have references to this craft as an important function of the Indian girl. She made baskets for her future home. Her value as a prospective bride was enhanced as her proficiency as a basket maker increased.

All kinds of Indian ceremonials were bound up with basket making, and different symbols were woven into the baskets according to the uses for which the baskets were intended. A wide variety of patterns including sun, moon, stars, animals, plants, clouds, trees, dances, weapons, ripples in the lake, birds in flight, lightning flashes, and zigzag spirals were woven in in pleasing combinations.

The oldest basketwork that has come down to us is the coiled or so-called Indian work. This type is common to many ethnic or culture groups, and a number of beautiful examples of it are still being woven by primitive peoples in America and Africa.

Colors in Indian Basketry. Craftsmen are interested in the colors the Indians used in making their baskets, and this subject is an education in itself. These colors were always pleasing, because they were natural colors —often faithful copies of the tints and hues that were to be seen in nature. The glory of the water tumbling over a high cliff, the golden clouds of sunset, the rainbow with its range of colors—all gave the Indian woman inspiration in the preparation of her various dyes. However, many of their basket patterns were the result of the happy mixture of natural materials of different shades. White, yellow, and brown were the natural colors of some of the materials used, and not produced by either bleaching or dyeing. Although the Indian women were skillful in the preparation of many dyes, they used most frequently red, black, and various shades of brown.

From the earliest times colors have had definite meanings. In ancient

art the proper use of each color was a matter of much consideration because each one had a mystic meaning or symbolism.

White is generally used to denote peace and happiness, purity and innocence. With some nations it was the color of mourning. White, however, really belongs to early Christian art rather than to primitive art.

Red is the color connected with power, both human and priestly. It speaks of fire, royalty, and spirit worship. It is the sacred color of the Indians and of many other peoples. For the Indian red stands for the East and for success.

In an opposite sense it symbolizes to the Indians blood, war, and hatred.

The Israelites covered their tabernacle with skins dyed red; and today red is the color that distinguishes the Pope and the Cardinals in the Roman Catholic Church.

To many nations blue naturally signifies heaven, heavenly love, truth, spiritual life, duty, and religion. But to the Indians blue represents the North with trouble and defeat.

Yellow is the color of gold, of fire, and of the sun. It symbolizes reason, the goodness of the Creator, and fruitfulness. A dirty, dingy shade of yellow, however, signifies jealousy and deceit. In most Biblical pictures of the betrayer Judas, the robes and cloak are a dingy yellow.

The color of Spring, green, among some Indians symbolizes vegetable life, utility, and labor, culminating in victory. The Indians of the plains, however, used green to represent ice and snow.

Black is associated with the West, and is the color of death among the Indians as well as the civilized races who use gray and black as the colors of humility and mourning.

It is interesting to note that the Indians represented the four cardinal points by colors, and there is always a logical meaning for the color chosen.

Types of Indian Baskets

Indian basketry may be divided into two types—the woven and the sewed. There is a large number of each type, owing to the different kinds of materials the Indian found near at hand. The variety of materials used by the Indian affects, of course, the color and pattern of the baskets and thus adds to their interest. In making and dyeing baskets the American Indian uses more than one hundred different plants. All kinds of grasses, palm leaves, pine needles, corn leaves, sweet grasses, cattails, cacti fiber, flag, hemp, yucca, willow, roots of spruce, cedar, alder, and the berries of the sumac tree are employed either as weaving strands or

coloring agents. All the colors for dyeing are obtained from roots, bark, or berries.

The type of plant fiber used of course determines the character of the basket. As a rule the fibers fall into one of three groups—round, flat, or flexible. Willow and reed of the round group are usually woven around other stiff, round reeds called spokes, radiating in a circle, much like the spokes of a wheel. Flat strips like cane, ash, and hickory splints are more readily plaited in and out of one another. Or they may be twisted over and under stiff upright reeds. The flexible strands, such as the grasses, or fibers of crushed stems, are generally sewed around a firm core in an ever enlarging coil, then upward in a spiral to form the sides of a basket.

Chapter II

BASKETRY MATERIALS AND TOOLS

Materials

The principal material used for the baskets described in this book is pulp reed. Nearly all the rattan from which these reeds are cut grows in the jungles of the Malay Peninsula. Rattan is a long trailing vine that hangs in festoons from the branches of trees or grows around the trunks. The vines are cut by the natives and left hanging until the bark becomes thoroughly dry. The rattans are then drawn through a notch cut in the side of a tree to strip off the outside bark and leaves. Bundles of rattans are then loaded on to rafts and floated down the rivers to the shipping ports.

In the factories the rattans are cut by special cutting machines into chair cane and reeds, the outside, or rind, being used for chair cane and the inside, or pulp, being cut into round and flat reeds (Fig. 1*A*).

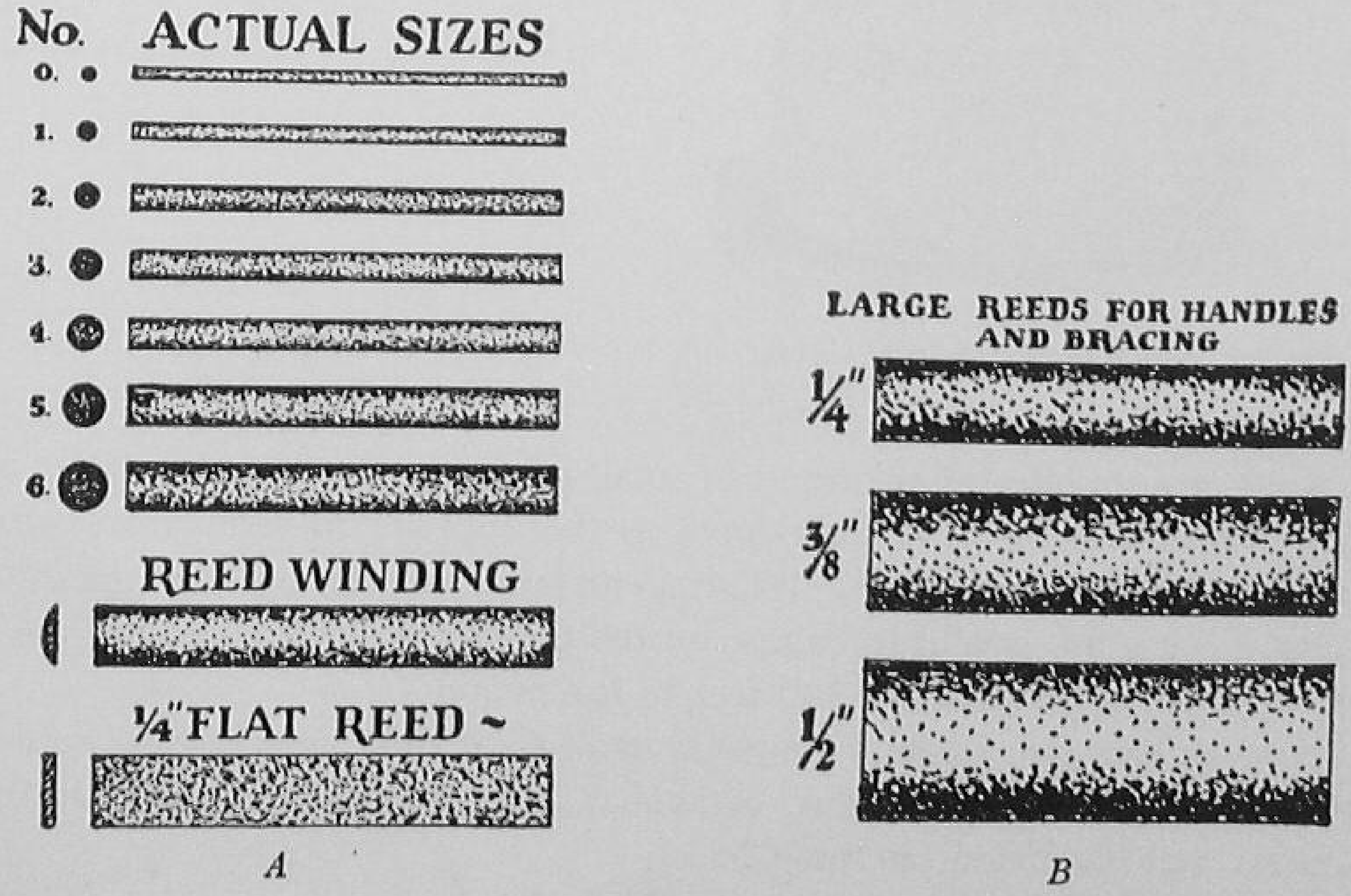


Fig. 1. Reed.

Round reed is sized from 00 to No. 10 (Fig. 1A). The finer reeds, numbered 00 to 1, are used for fine baskets; Nos. 2, 3, 4, and 5 are the popular sizes; Nos. 6 to 10 are used for handles and spokes in heavier baskets or reed articles. Flat reed is sized $\frac{3}{16}''$, $\frac{1}{4}''$, and $\frac{5}{16}''$, the one popularly used being $\frac{1}{4}''$ in width (Fig. 1A). Winding material used for binding handles and frames is of one size only.

As a change from reed in basket filling, Hong Kong grass (grass twine) is used. It is a very strong material, $\frac{3}{16}''$ in diameter, and comes in a twisted strand in natural and dark green color (Figs. 2A and B).

FIG. 2A. Hong Kong Twisted Grass.

No. 1 TWISTED GRASS

No. 3 TWISTED GRASS

FIG. 2B.

Reeds are sold by the pound or in small packages. However, it is advisable to purchase them by the pound, as this supplies material for several baskets at a minimum cost. Winding material is sold by foot measure. Hong Kong grass is sold in hanks, by the pound. A hank contains 3 to 4 pounds with approximately 280 feet to the pound.

Wooden bases for baskets are made in all sizes and many shapes; round, oval, rectangular, half-circular, octagonal, etc. Any number of beautiful articles may be made on these bases.

Wooden frames and stands for such articles as lamps, smoking stands,

flower stands, end tables, and many others, ready for reed work may be purchased.

Decalcomania transfers, designs suitable for the bottoms of trays or for use on furniture, now very popular, are made up of natural-colored fruits, flowers, and birds in different sizes.

Basketry Tools

Very few tools are necessary in the beginning stages of basketry. Fig. 3 shows the essential tools; where possible a reasonable substitute is given.

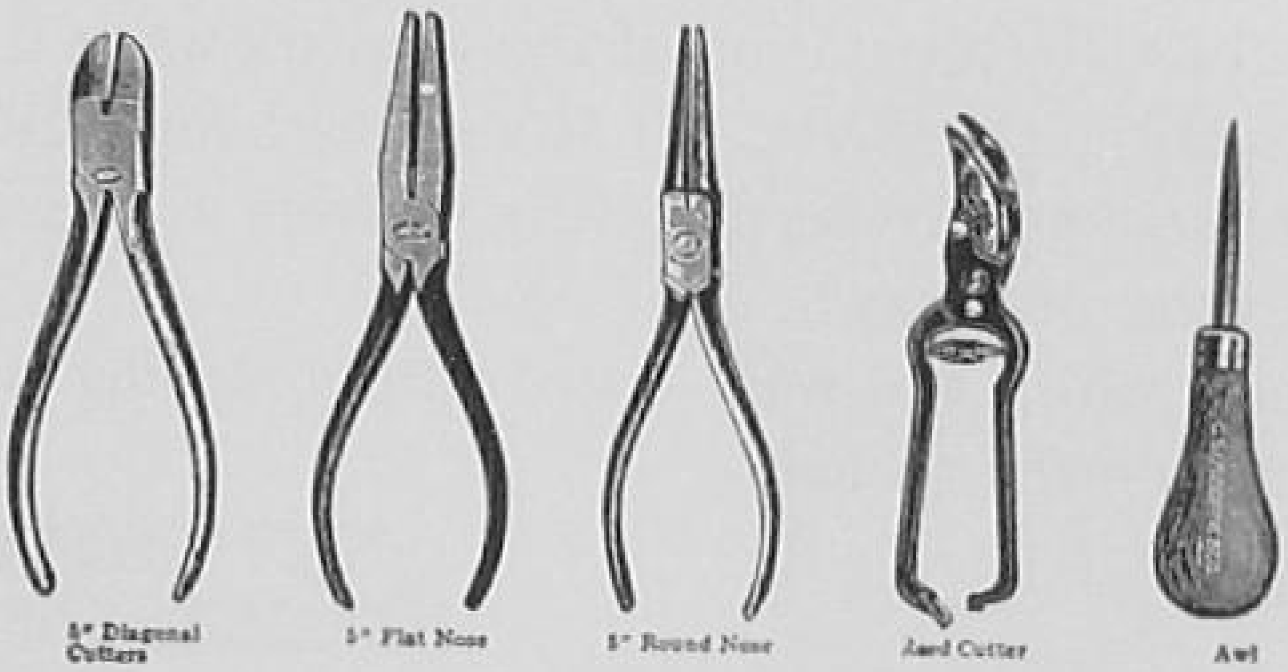


Fig. 3. Basketry tools.

A reed cutter or diagonal cutters are used for cutting the cane generally, the uprights (stakes or spokes), surplus ends, etc.; ordinary scissors are not strong enough. Cutting a number of the spokes at one time is possible

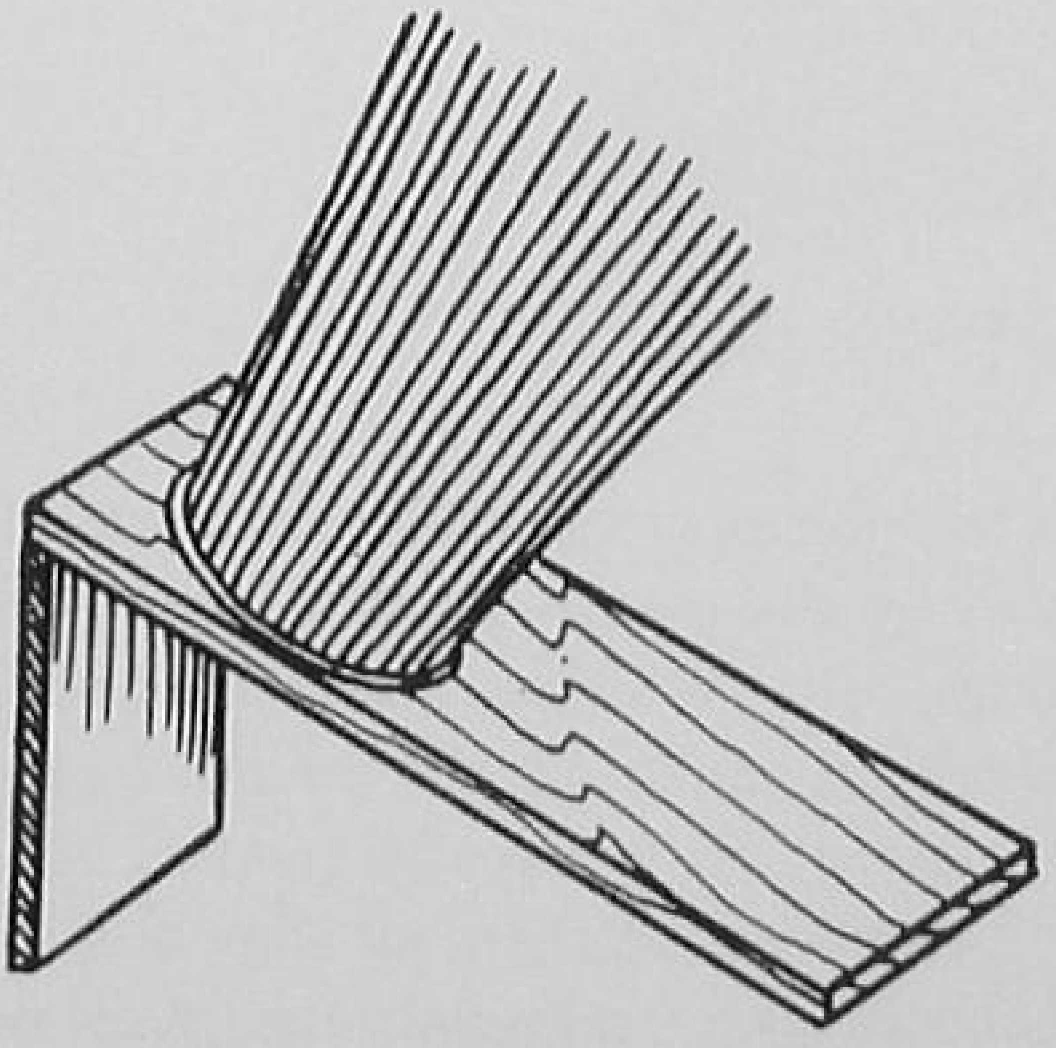


Fig. 4. Basket board. A sloping surface on a firm foundation, with the longer piece 12″ by 8″, the shorter, 5″ by 8″.

with these tools by holding several strands of reed together. For a class two or three pairs of cutters are all that are necessary.

Round-nosed pliers are used for squeezing reed before bending it, when working some of the borders, etc., to prevent the reed from cracking.

Flat-nosed pliers are used in pulling reed uprights through holes in wood bases. The flat snub ends grasp the reed more firmly than do the round-nosed pliers.

A knife is used for pointing the spokes if necessary, also for cutting the ends of cane on wooden bases if they would be difficult to cut with a reed cutter.

An awl is used for the separation of the weaving when it is necessary in order to insert additional weavers. It is also used for marking boards for drilling holes for spokes. To separate the weavers a large knitting needle may be used instead of an awl.

A basket board, which is a work board with a sloping surface (Fig. 4), is used on which to make baskets.

Chapter III

HINTS AND GENERAL INSTRUCTIONS

Hints For Beginners

The following hints are the outcome of the experience of many years of practical basket making and teaching of basketwork.

1. Reed must never be worked dry, for it will crack. Pass it through water and allow it to drain a few minutes before using it. Have a wet cloth or sponge at hand to dampen the reed as it becomes dry during the working.

2. The first articles made should have a wood base, as a firm foundation is easier for a beginner than is a flexible one. Not until the worker has become accustomed to using the reed should he attempt weaving a reed base.

For school use birch bases are recommended in preference to oak, as the former are less expensive. All the bases used in the illustrations in this book, with the exception of the tray base, are of 3-ply birch, ⅛″ to $\frac{3}{16}$″ thick, and termed learners' or beginners' bases. The tray, being larger, requires a thicker 3-ply base, preferably ¼″ birch.

3. Generally speaking, the steps in making a basket with a wooden base are as follows: (a) Cut the stakes (or spokes), and insert them in the base; (b) work the ends under the base into a border, called a foot border; (c) upset and weave the sides; (d) work the remainder of the stakes into a border for the top edge of the basket; (e) attach a handle if one is desired.

4. For good results it is essential to work in a comfortable position. Trays can be worked on a flat surface, such as the top of the desk, but for baskets a work board with a sloping surface should be used (Fig. 4). This can be made very easily in a craft shop. It consists of two pieces of wood, one 12″ by 8″, the other 5″ by 8″, nailed together in the position shown in Fig. 4, and used on a desk or a table. The raised end faces the worker and the basket is pinned through the center of the base to the sloping board with a small awl, with the edge of the base along the front edge of the board. In this position the basket can be revolved easily during the weaving and any mistakes can be quickly seen and corrected at once.

5. The weaving is generally worked from left to right and on the side of

the basket near the worker, not on the far side; each stroke should be held in position with the left thumb and forefinger, while the next stroke is worked with the right hand. Keep the weaving close and firm; do not allow it to get at all "cobwebby" in appearance. It is not necessary, however, to pull the reed tight. Nor is it necessary to grip the reed too firmly. Beginners often have the tendency to grasp the reed strands too tightly, which causes cramped and tired fingers.

6. The stakes, or spokes, which are the upright, or foundation, reeds of a basket, should always be somewhat larger in diameter than the weaving reeds (or "weavers"). They are spaced at regular intervals and must be kept upright, not pulled forward, during the weaving.

7. In storing unfinished work, do not allow the stakes to be pressed out of shape. Before resuming the weaving, moisten the uprights but take care that the wood base does not become water soaked, and thus lessen the value of the finished basket.

8. Do not use a very long piece of reed for weaving. A length should not exceed 3 yards, for it is a simple matter to join reeds, as described later.

9. When the work is finished, cut off with a slanting cut any protruding ends, so that the ends are flush with the work. To make sure of this, rub the hand over the basket to see if it feels quite smooth. Do not cut the ends too close, however; each end should rest securely against a stake.

10. The appearance of the work is greatly improved if the protruding "whiskers" or thin fibers of the reed are singed off with a Bunsen gas burner or a methylated spirit lamp. Do not use a wax taper, as it will blacken the reed.

11. The way reed is stored before it is used is important. The lengths should be as straight as possible if good work is to be done, so that it is not advisable to keep it tightly coiled in a cupboard. The reed is supplied in bundles, all the lengths being bent in half for convenience and measuring approximately 10 feet from the bend, making the total lengths 14 to 20 feet. These are, of course, too long to be practical, for, as previously mentioned, the lengths should not exceed 3 yards. As it is almost impossible to straighten the bent part of the reeds, it is advisable to cut this portion from the entire bundle for a depth of 1″. The reed will then be in suitable lengths for use, and the benefit derived in avoiding the "bends" will be well worth the small waste incurred. Furthermore, the shorter length is much more convenient for storing. The ideal method of storing reed is to lay it flat in long racks, but often in a school room this is not

possible. The next best way is to hang it up. Bend it, not with an acute bend, but a broad loop, and tie it together with a string or raffia about 12″ down. Then it can be hung on some convenient peg or nail, and when not in use can be covered over with a cloth or paper to keep it clean. It should not be placed near hot water or steam pipes, as this will make it brittle and thus likely to break easily.

General Instructions

Soaking Reed

All spokes and reeds must be soaked thoroughly in warm water before being used, to render them pliable and prevent their breaking and splitting. They must be kept moist while being worked, for the same reason. The time required for the preliminary soaking varies with the size of the reed—from ten minutes for the finest reed to one-half hour, or perhaps longer, for the coarser reeds. Reed should not be soaked so long that it becomes fibrous. While working, moisten the weavers, or weaving lengths, with a sponge or cloth, as they dry out. They should always be pliant enough to weave smoothly.

Cutting Reed

Cut round reeds on a slant when using them as spokes or as weavers, or when finishing off in a border—for two reasons: they slip into place more easily and give a neater appearance to the finished article.

Inserting Spokes Through Holes Bored in Wood Base

The length of spokes to be used in wooden bases must include the 2″ that is needed to form the base border, plus the length necessary for a specific border treatment, in addition to the length for the height and the slope of the basket.

The spokes are inserted through the holes in the base, the ends extending about 2″ (Fig. 7). A slight twisting motion on the spoke will aid in the inserting operation. The spokes are left protruding through the base until the decorative edge operation is completed.

Making Decorative Edge

The edge can be woven in either the criss-cross weave (Fig. 5*A* and *B*), or the over-edge loop (Fig. 6*A* and *B*). For either, one weaver No. 0 is generally used.

Crisscross Weave Edge Treatment. Slip a fine weaver behind a spoke,

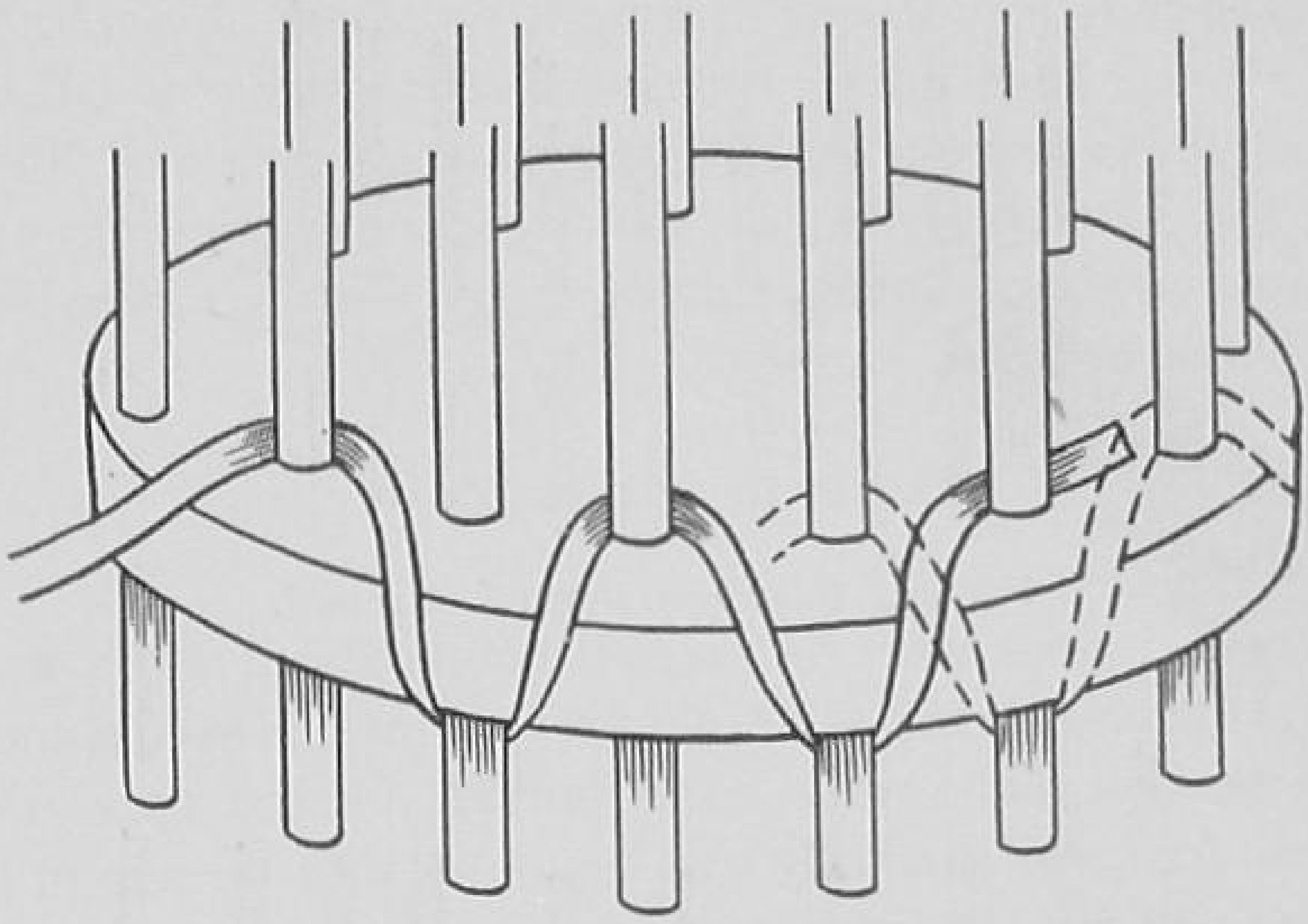


FIG. 5A. Crisscross weave; first round.

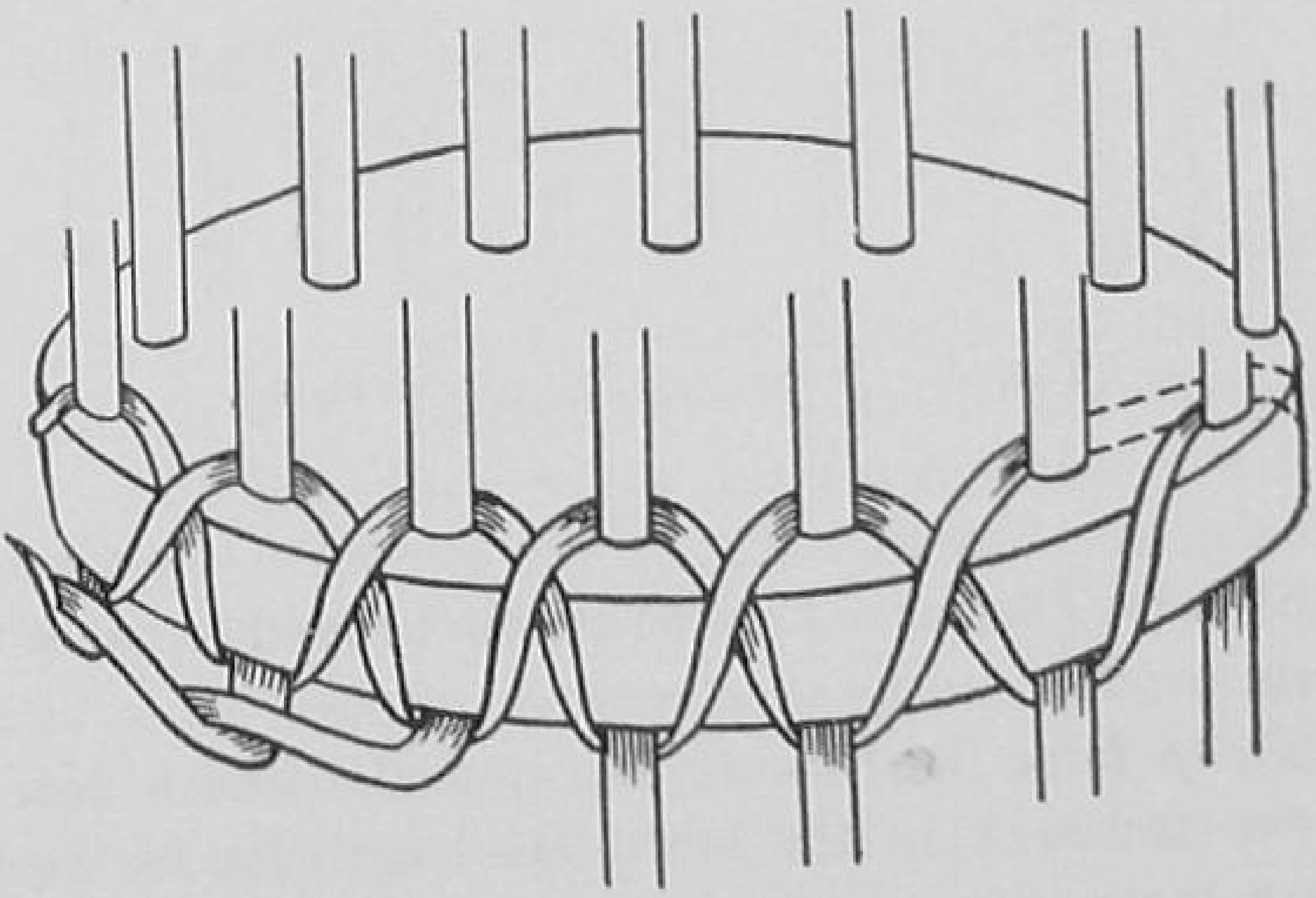


FIG. 5B. Crisscross weave; second round.

with the end pointing toward the inside of the basket. Bring it out over the edge of the base and behind the next spoke, on the underside of the base (Fig. 5*A*). Cross the weaver over the edge again and pass behind the second spoke to the right on the top of the base. Continue weaving behind every other spoke first on top of the base and then underneath, crossing over the edge between stitches. If the base has an uneven number of spoke holes, the weaver on its second round (Fig. 5*B*) will pass behind the spokes that were omitted in the first round. In passing over the edge of the base between stitches from top to bottom on the second round an X

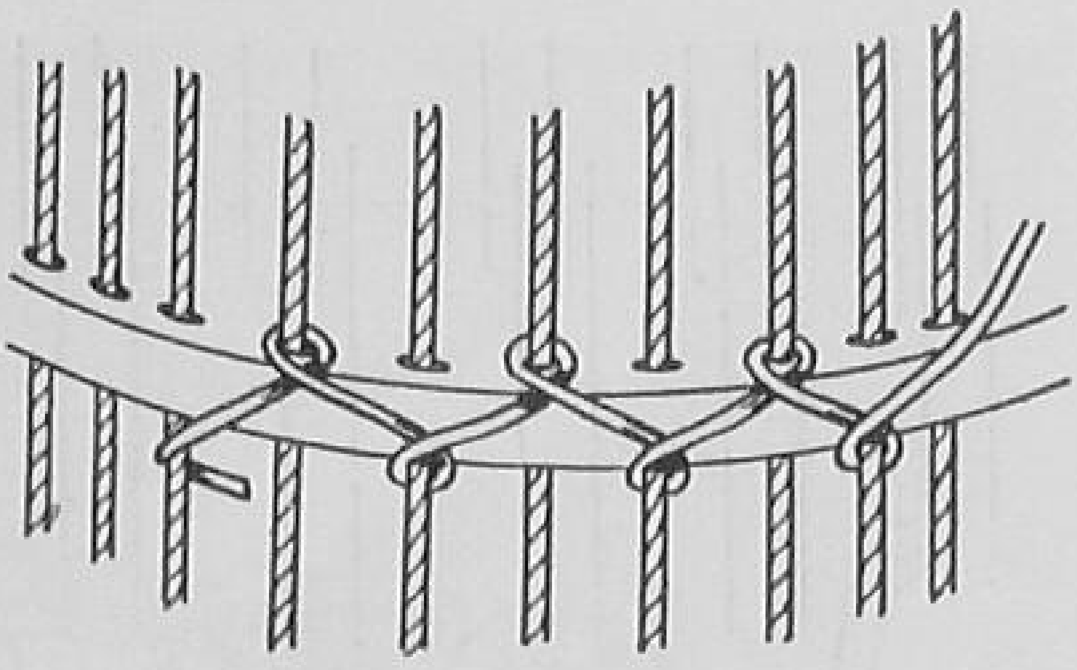


FIG. 6A. Over edge loop; first round.

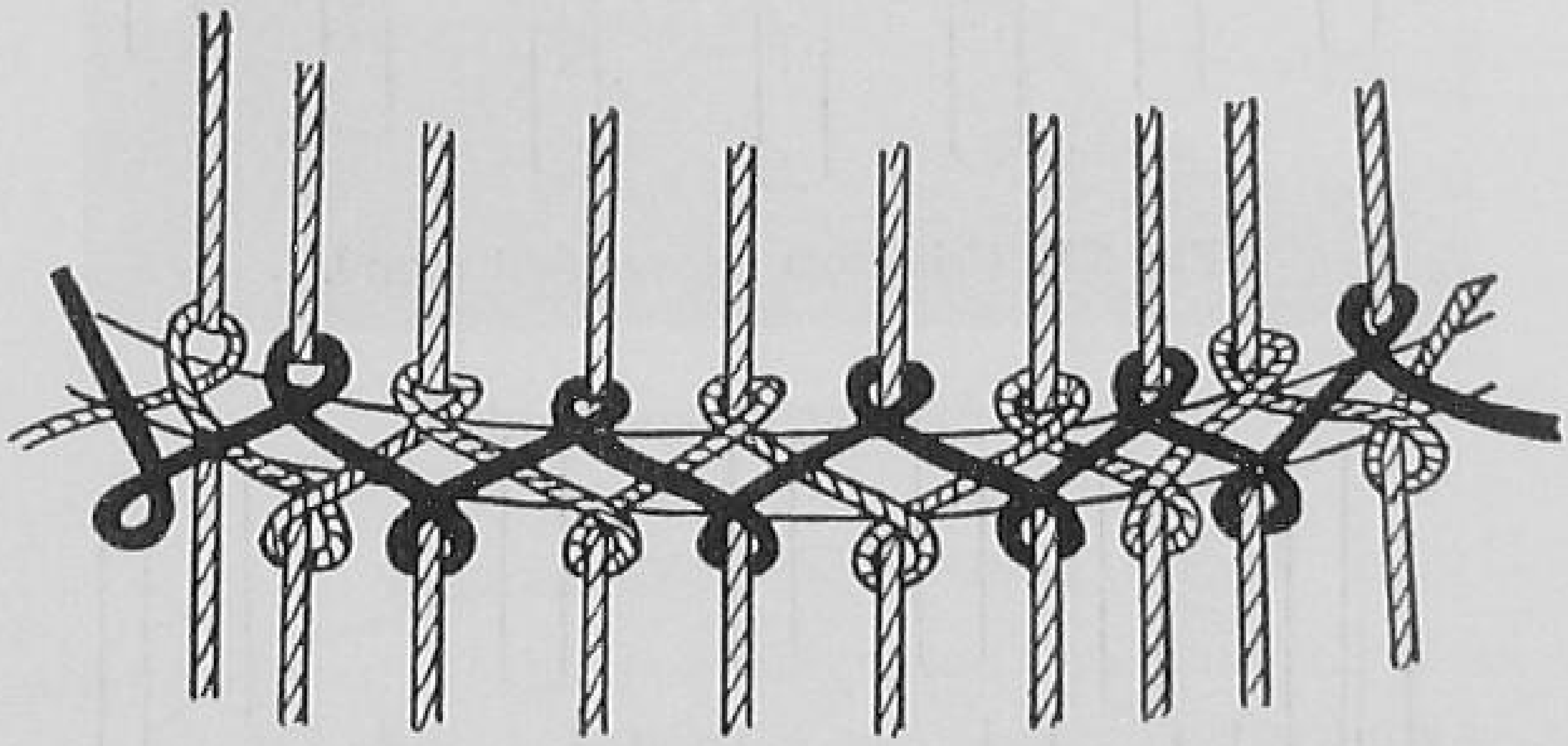


FIG. 6B. Over edge loop; second round.

is made. If the base has an even number of spokes the weaver must be passed behind two spokes at the end of the first round to cause the alternation and form the X.

Overedge-Loop Edge Treatment. Insert the end of a No. 0 reed between any two spokes below the base. Cross the edge of the base to the top and carry the weaver to the right completly around the next spoke, above the base (Fig. 6*A*). Then cross the edge to the right and carry the weaver completely around the next spoke, below the base (Fig. 6*A*). Repeat this operation, crossing the edge of the base from top to bottom, until you reach the starting point. Turn the base upside down and repeat the operation. The weaver is now carried around the spokes that were not used before (Fig. 6*B*), crossing the weaver of the first row in going over the edge each time. At the completion of the second round cut the weaver and turn the end under an adjoining loop.

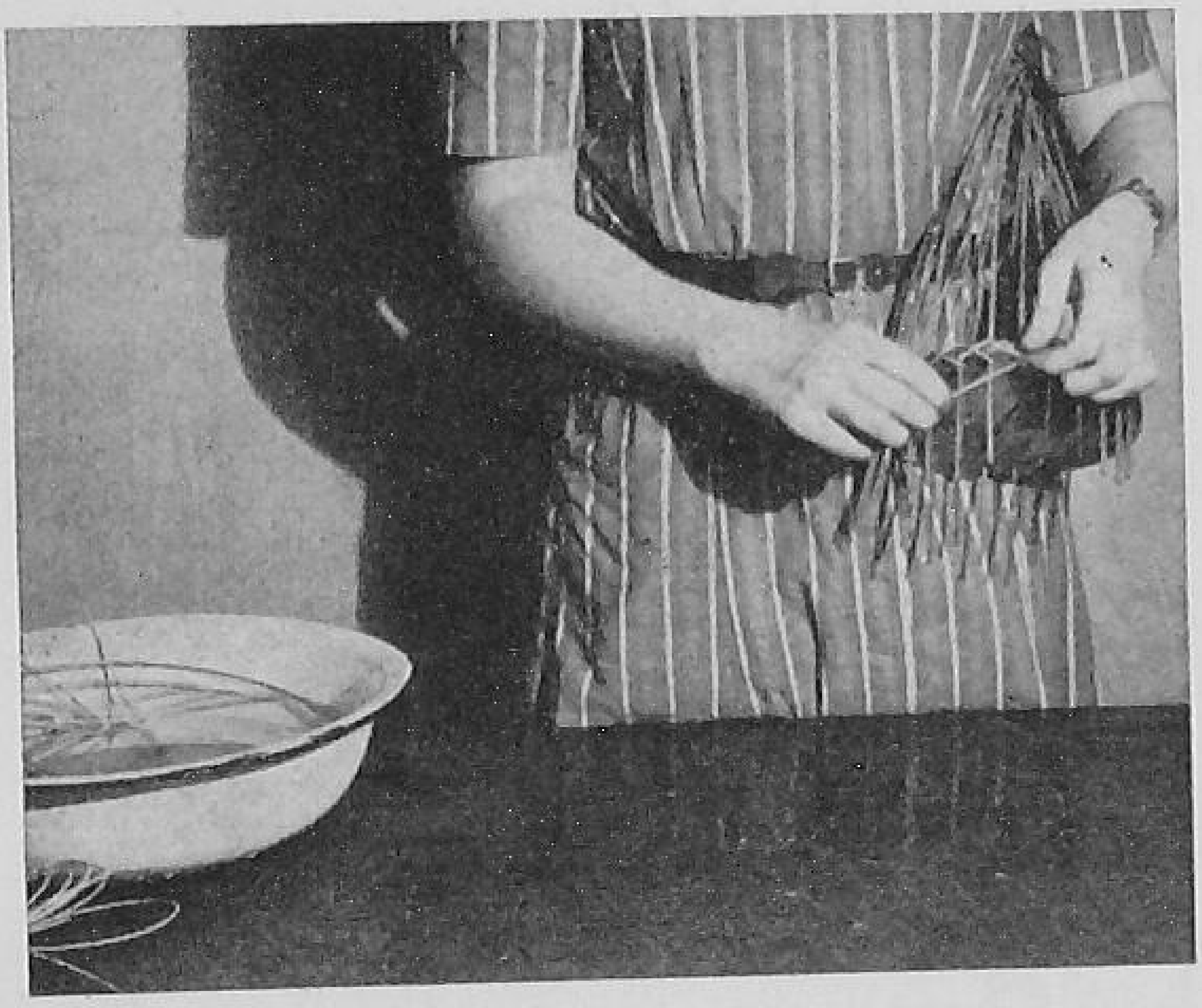


FIG. 7. Starting of base border.

Turning Under Spoke Ends For Base Border

The spoke ends must be thoroughly soaked 10 to 15 minutes so that they will fold quite close to the base without breaking. Take care that the wood base does not get wet, or warping may occur. By placing the basket

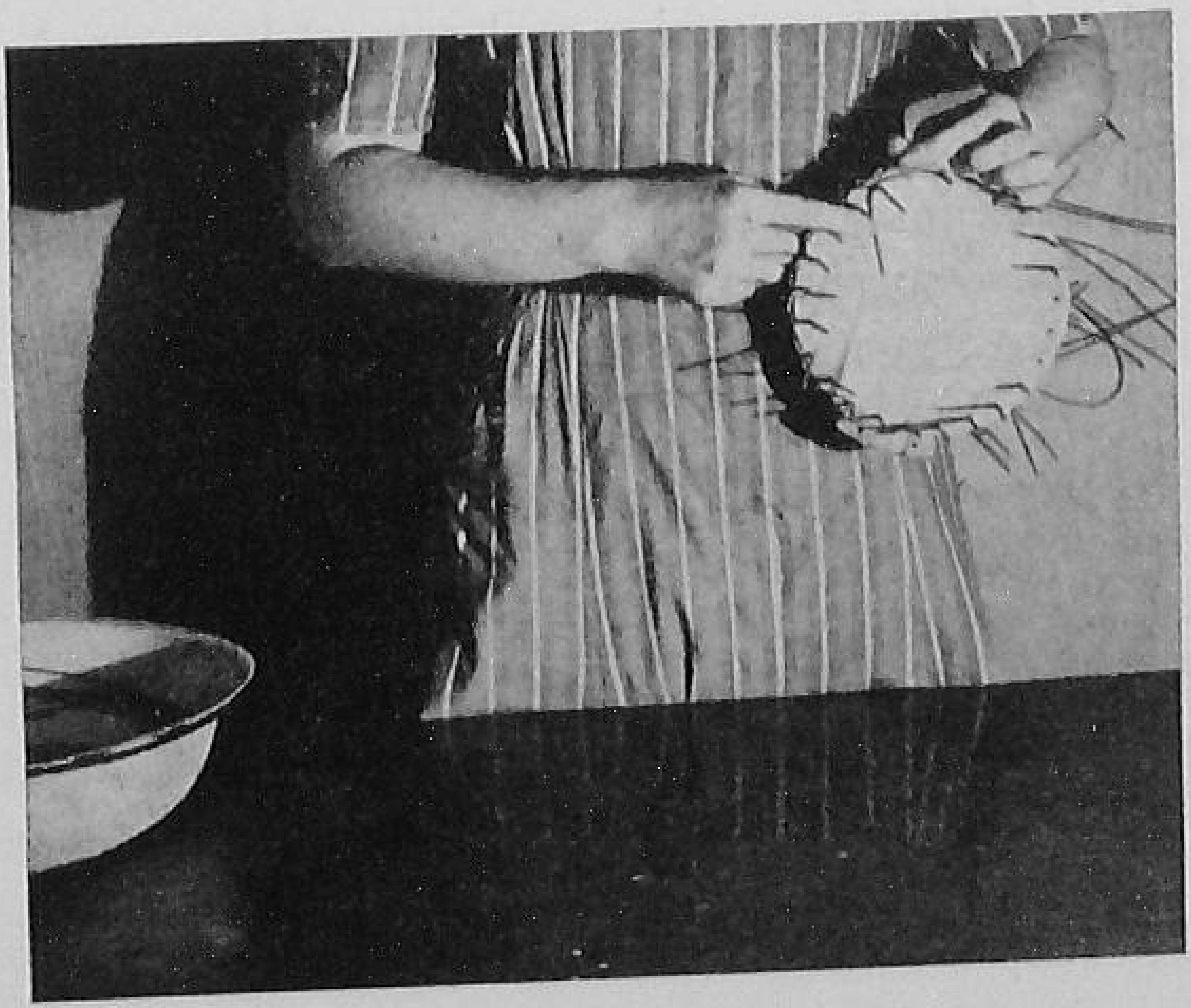


FIG. 8. Base border—Second step.

in a low receptacle with the level of the water just covering the spoke ends, these may be soaked without the base getting wet. Then hold the basket base with the short spoke ends extending downward. Pass each spoke end in front of the spoke on its right (Fig. 7), behind the next one (Fig. 8),

FIG. 9. Continuing base border.

and to the inside of the base. Each end should be at least ½″ to the inside of the second spoke. This eliminates any chance of the ends becoming loose and snapping out of place (Fig. 10).

The ridge made by the interlocking spokes must be pressed as close to the basket as possible so that a uniformly high border is obtained (Fig. 9). The entire base border may be wrapped with cord as shown in Fig. 27 to insure a smooth, nonscratching base.

Square corners need special care in order to retain the angle to insure a level, well-balanced tray or basket (Fig. 10).

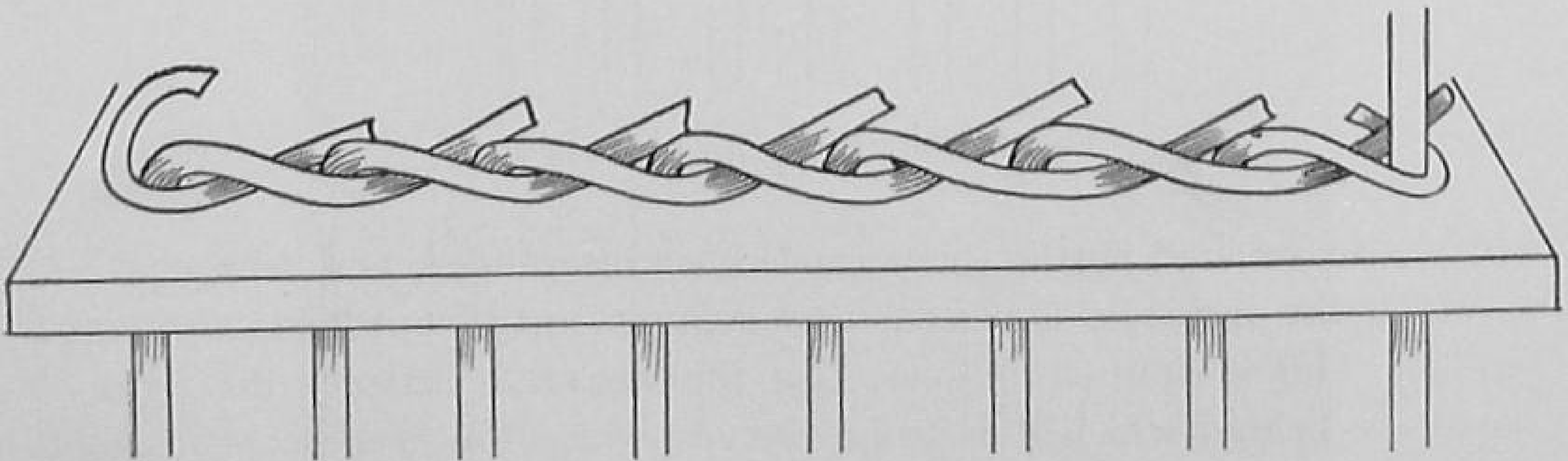


FIG. 10. Base border on square or rectangle.

Insertion of Double-Length Spokes

On a tray that must be as flat as possible in order to rest on a table surface the base border is eliminated by cutting the reed in lengths long enough for two spokes. The lengths are soaked sufficiently to allow a very close fold, then folded in the middle, and inserted in adjoining holes on a basket or tray frame (see the refreshment tray in Fig. 65).

Piecing Weavers

A new weaver can be inserted whenever necessary. Weavers are pieced in either of two ways: as *open* piecing or as *hidden* piecing, depending upon the kind of weave used, the type of basket, and whether or not the piecing will be seen. For instance, in sewing baskets that are to be lined

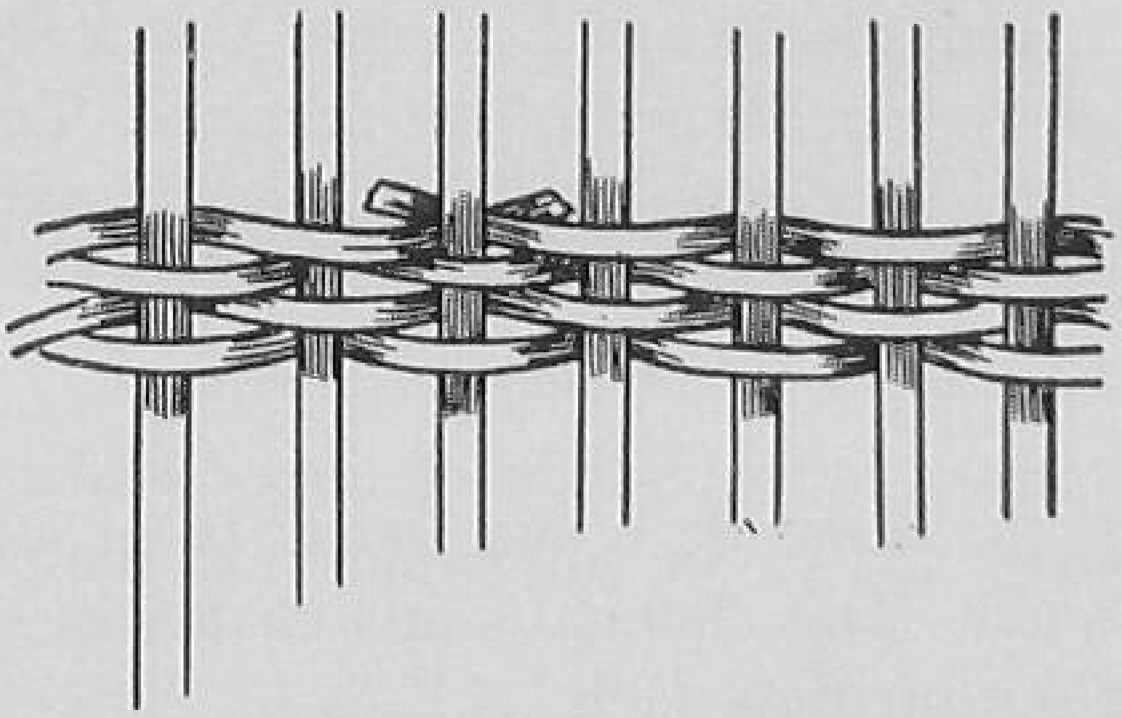


FIG. 11. Open piecing.

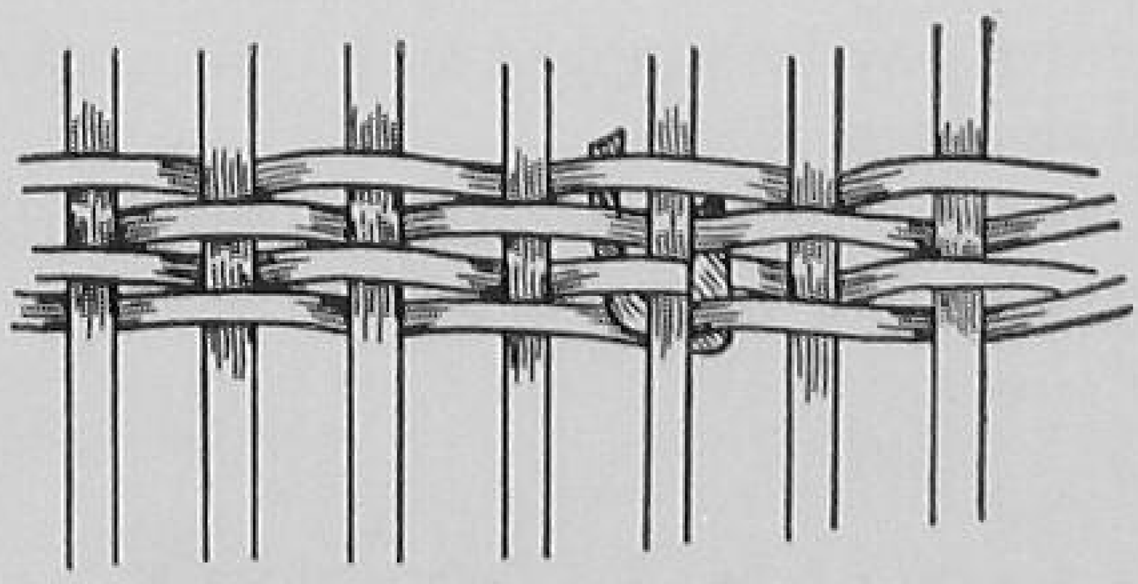


FIG. 12. Hidden piecing of weavers.

with fabric, covered bottles, bowls and other receptacles, and deep baskets, of which the inside is not seen, new weavers may be added with open piecing. This is done as follows: Cut the weaver a little to the right of the spoke behind which it is to be pieced. Place the new weaver behind the same spoke so that it crosses the old weaver (Fig. 11) and continue

weaving. Note that the new weaver now comes from the same place from which the old one did before the piecing.

All articles that show both sides of the weaving require *hidden* piecing when new weavers are added. This is done as follows: Cut the weaver a little to the right of the spoke behind which it is to be pieced. Turn the end down beside the spoke and tuck it in. Insert the *new* weaver behind the same spoke so that it crosses the old weaver (Fig. 12). Turn the end down on the left side of the spoke, tuck it in (Fig. 12), and continue weaving. When two or more weavers are held together and used as one weaver, use open piecing when adding new weavers, always inserting new weavers *below* other weavers. Trim the ends carefully to give a neat appearance. Flat reed, owing to the width, is always open-pieced on the inside of the article.

Winding material is pieced as follows: When the winder is within 7″ of the end, put in a new winder and bind over this a few times, then use the new winder to bind over the end of the first one. To make this a neat piece of work keep the winder wet and bind tightly and evenly.

Shaping Articles

Spokes of all baskets, but especially of larger baskets, such as waste-baskets, window boxes, and so on, will conform to the desired shape more

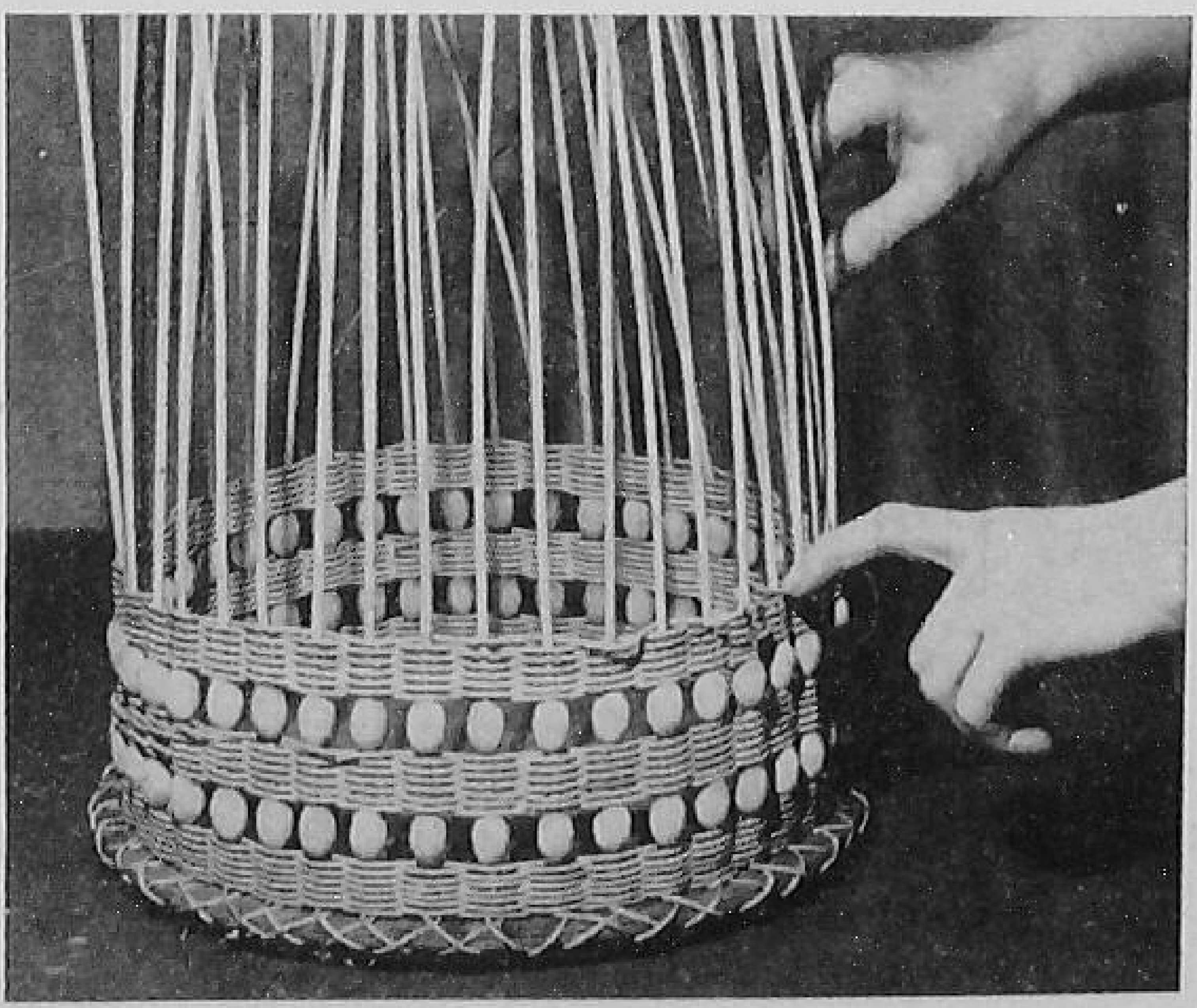


FIG. 13. Shaping sides of basket.

easily if they are regulated with an awl and pulled tight after every tenth or twelfth row of weaving. The secret of shaping baskets made entirely of reed rests upon the regularity of spaces between the spokes, and the tightening or loosening of the weavers (Fig. 13). For a basket that is to shape outward, increase the distances between the spokes and weave a trifle more loosely. For a basket that is to decrease in width, weave tighter, thus drawing spokes closer together.

Changing Weaves

When changing from one weave to another, if new weavers of a different size are to be used, insert them behind spokes some distance from those behind which the last weave was ended, and thus avoid crowding several ends at one spot. Remember that each section of a particular weave is individual and may be started behind any spoke, but be careful to end each weaver behind the spoke from which it started. It is well to mark the starting point of a weave so that you can readily tell when a row is ended.

Singeing

In weaving, the reeds are likely to roughen and short fibers appear. These are singed off at the completion of each model. It will not be necessary to wait for the reeds to dry thoroughly before singeing them; in fact, they are more likely to scorch while being singed, if perfectly dry than if slightly moistened. A small alcohol lamp may be used with great satisfaction, although any small blue flame will do. A yellow flame will smoke and darken the reed.

Finishing in Different Mediums

Reed in itself is very strong and durable, but like wood it is improved with a preservative, which adds to its firmness and its years of service, besides enhancing its beauty. There are many finishes that may be applied to reed—all good—it is simply a matter of deciding upon which medium to use to produce a desired effect—perhaps a contrast to another color or a harmonizing with surrounding colors. A mixture of white and orange shellac, which gives a richer tone than plain white shellac, applied in two thin coats, will preserve the natural reed color as a contrast to darker tones of furniture or surroundings. Shellac dries quickly, but should be given extra time for hardening.

Enamel is easily applied to reed over an undercoat of paint, which is usually the same color as that of the enamel. Before the enamel is applied

the flat undercoat must be thoroughly dried. The enamel takes longer to dry than does the paint. Although enamel is easily applied to reed it coats the surface in such a way that much of the beauty of the natural material is lost.

Wood stains or dyes are also used as finishes, with very satisfactory results. These are usually applied lightly, rubbed in well with a cloth, and allowed to dry for a few hours, then a medium coat of shellac is applied and allowed to harden overnight, before being handled.

Lacquer, a more recent medium than enamel or stain, is best applied over an undercoat of shellac, which has been allowed to harden. One coat of lacquer, put on with a soft-bristle brush, should be sufficient, but if a second coat is required, allow at least thirty minutes between coats. Lacquer dries quickly and produces a smooth, satin finish.

Transfering Designs

Decalcomania or transfer designs, in colorful fruits, flowers and birds, applied to woven or caned trays give an effect of hand painting. To apply a transfer, coat the face of the transfer thinly with white shellac, place the transfer in position with the shellac side down, hold firmly, and rub hard with a dry cloth. Allow it to dry and harden at least an hour. Next, soak the paper with water and remove it—it will come away easily. Then clean the edges of the design with alcohol.

Chapter IV

WICKER WEAVES

In general, all basket weaving is done from left to right, unless individuals find it more advantageous to carry the weaving strands in the reverse direction.

Over-and-Under Weave (also called Randing, Simple Weave, In-and-Out Weave)

An uneven number of basket spokes is required if a single weaving strand is to be used, so that the weaving strands on the second circuit around the basket will alternate with the course followed in the first circuit.

One end of the length of reed weaver is placed between two spokes with the end pointing toward the inside of the basket.

The weaver is passed in front of one spoke and behind the next around the basket base. See Fig. 14, which shows the single weaver being carried to the left.

With an uneven number of spokes, the weaving can be continued in the next row with the same reed strand. It will be noted that in the second circuit around the basket the weaver passes under the spokes that it passed over on the first circuit; and over the spokes that it passed under in making the same circuit.

For an even number of spokes two weavers are needed. The first weaver is passed under and over alternating spokes around the basket to within two spokes of the start. The second weaver is inserted behind the spoke to the left of the first weaver's start and alternates with the latter's course around the basket. Weaving is continued in successive rounds, each weaver's circuit being stopped two spokes to the left of the previous weaver's stop, the latter being taken up on the next round. The first weaver will be brought up over the second weaver on the inside of the basket and used for the third row. The second weaver will cross over the round made by the other weaver in completing the third circuit and is used for the fourth row, and so on. The two weavers must not be

allowed to overtake each other. This condition means that as soon as the weaver of the previous round is reached, the weaver in use must be left and the work continued with the other weaver.

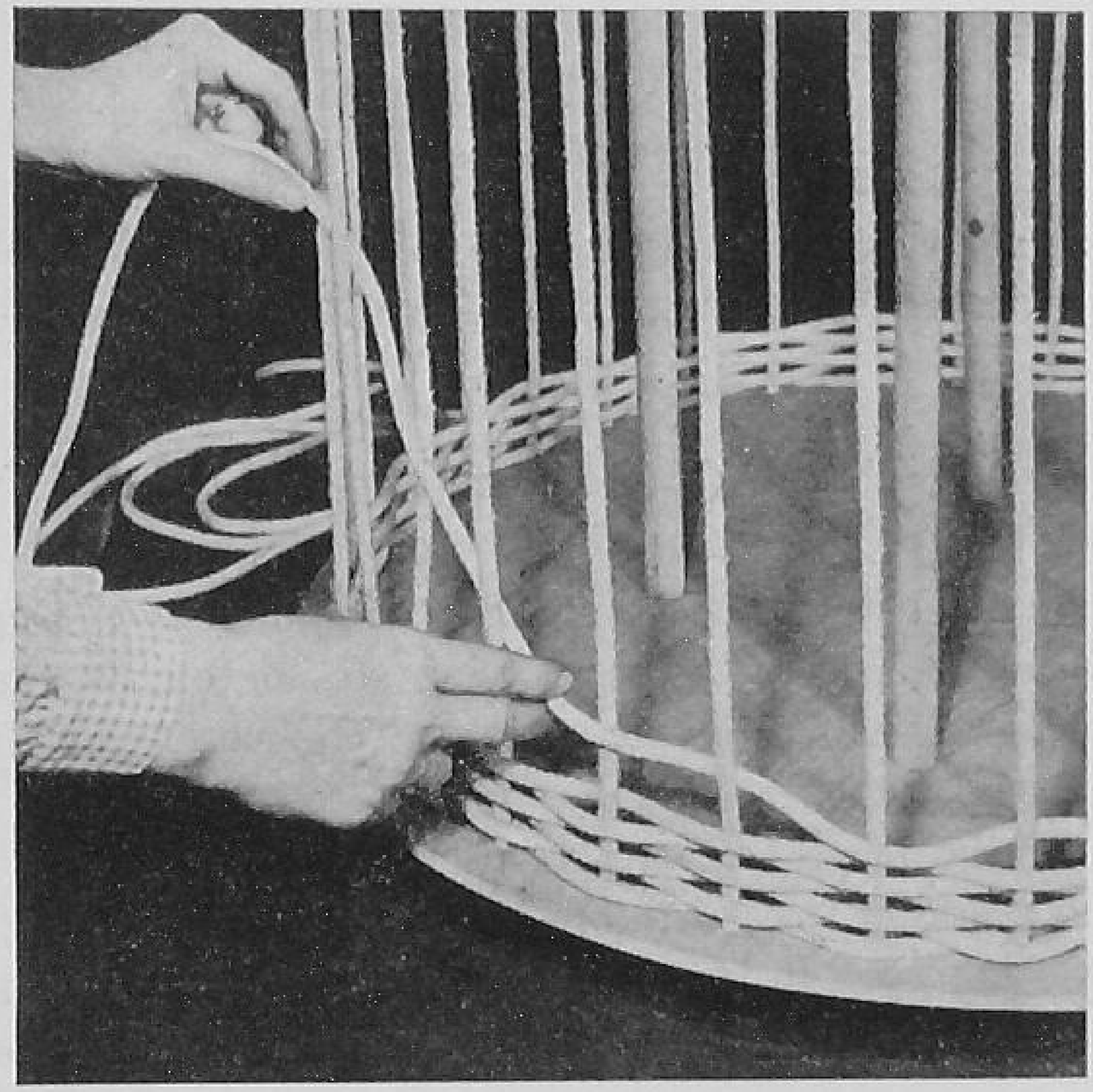


FIG. 14. Simple over and under weave.

Double Over-and-Under Weave (also known as Slewing)

This weave is the same as the simple weave, with two parallel weavers carried as one—in front of one spoke, in back of the next one, and so on.

If there is an uneven number of spokes, use two parallel weavers carried as one (see Fig. 15). If there is an even number of spokes, two pairs of parallel weavers are necessary. The first pair, started between any two spokes, is passed over and under alternating spokes, around the basket to within two spokes of the start. The second pair of parallel weavers is inserted behind the spokes to the left of the first pair's start and alternates with the latter's course around the basket. Weaving is continued in successive rounds, the circuit of each pair of weavers being stopped two spokes to the left of the previous pair of weavers, and the latter being taken up on the next round. The first pair of weavers will cross the other pair on the inside of the basket and be used for the third and fifth rows.

The second pair of weavers will cross over the first pair and be used for the fourth and sixth rows, and so on. They must not, however, be allowed to overtake each other. This condition means that as soon as the starting

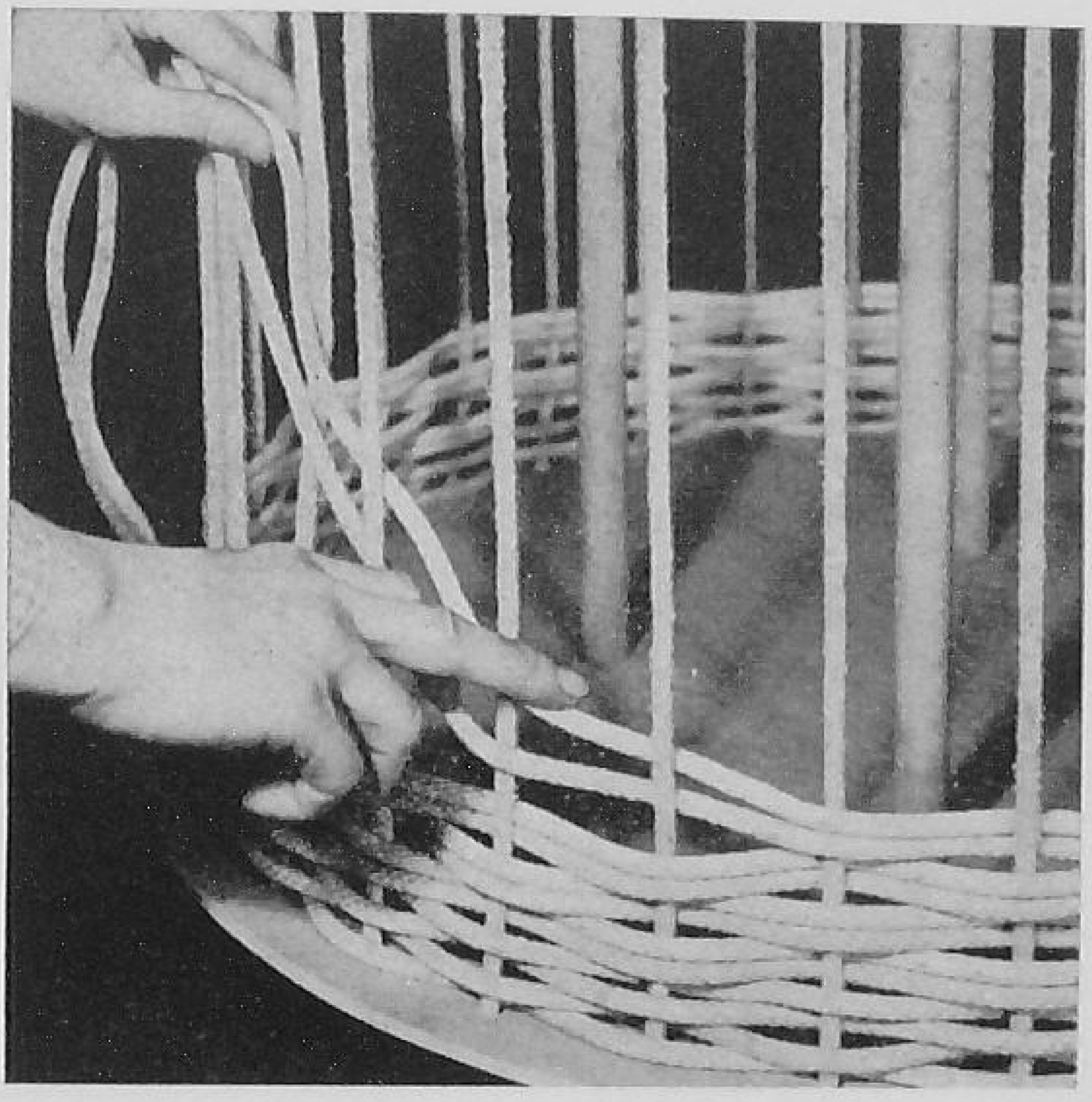


FIG. 15. Double over and under weave.

location of the pair of weavers of the previous row is reached, the pair in use must be left and the work continued with the other parallel pair.

At the start of the second round by either pair of weavers the crossing of the previous pair produces a slanting stitch on the inside of the basket that serves as an indicator of the location for the cessation of weaving with one pair and the continuing with the other pair.

The changing point of the weavers is very easily determined after several circuits of the basket have been completed as the slanting stitch of the cross-overs produce a definite spiral on the inside of the basket.

Triple Over-and-Under Weave (also known as Slewing)

This is merely a simple weave or randing with three parallel weavers (Fig. 16).

Colored reed may be introduced if desired. Either a colored reed with

an undyed reed on either side may be used, or two colored reeds with a single undyed strand between them.

Care must be taken to keep an even tension on all three strands so that the basket surface appears regular and even.

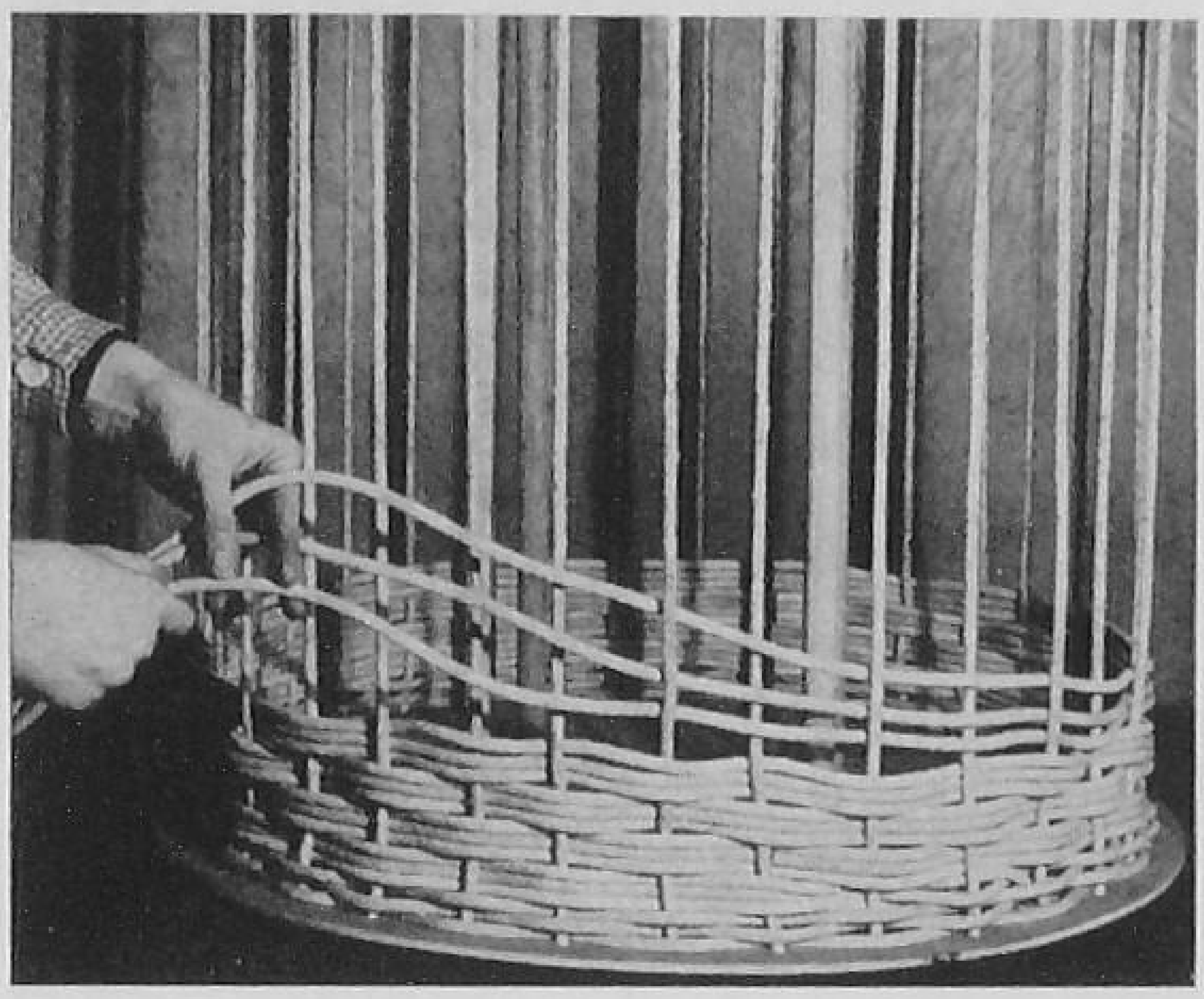


FIG. 16. Triple over and under weave.

The weaving process is the same as that for simple over-and-under weave, either for an uneven or an even number of spokes, with the three parallel weavers used as one.

Simple Pairing

A single weaver is inserted in back of two successive spokes. The left weaving strand is passed in front of the first spoke, over the other weaver, and in back of the next spoke (Fig. 17). The second weaver, which is now the left weaver, is carried in front of the first spoke (the same spoke that the other weaver passed behind), over the other weaver, and behind the next spoke. This process is continued around the basket, so that each weaver in turn becomes the left weaver. Pairing weave is always done in this way, whether over a single spoke or groups of spokes. The process is the same whether started by placing the single weavers behind two successive spokes or by folding a long weaving strand double, and slipping the loop end over a spoke or group of spokes (Fig. 18) with the ends

pointing to the outside of the basket. This procedure will provide the necessary two weaving strands with which to do the pairing weave.

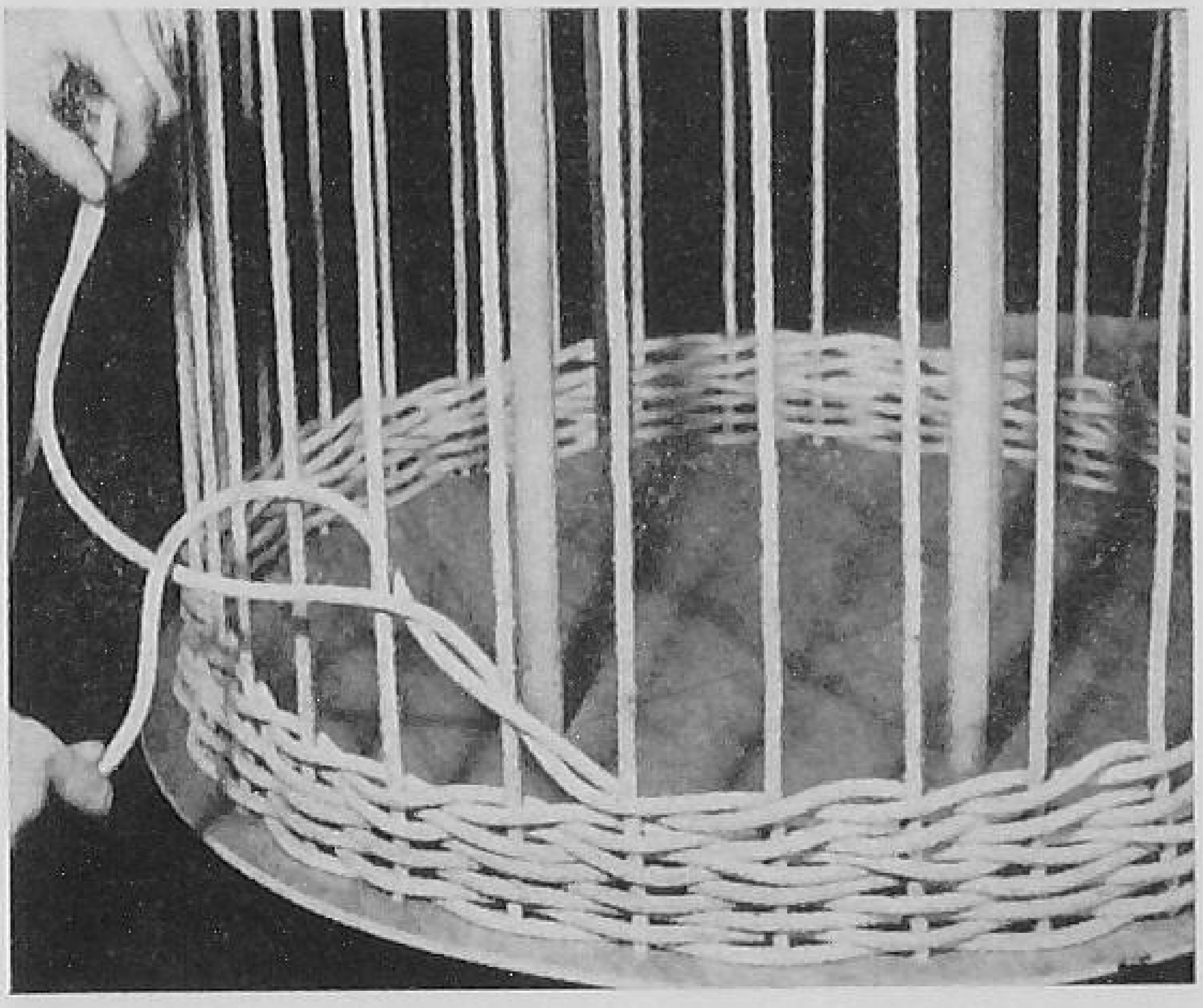


FIG. 17. Simple pairing weave.

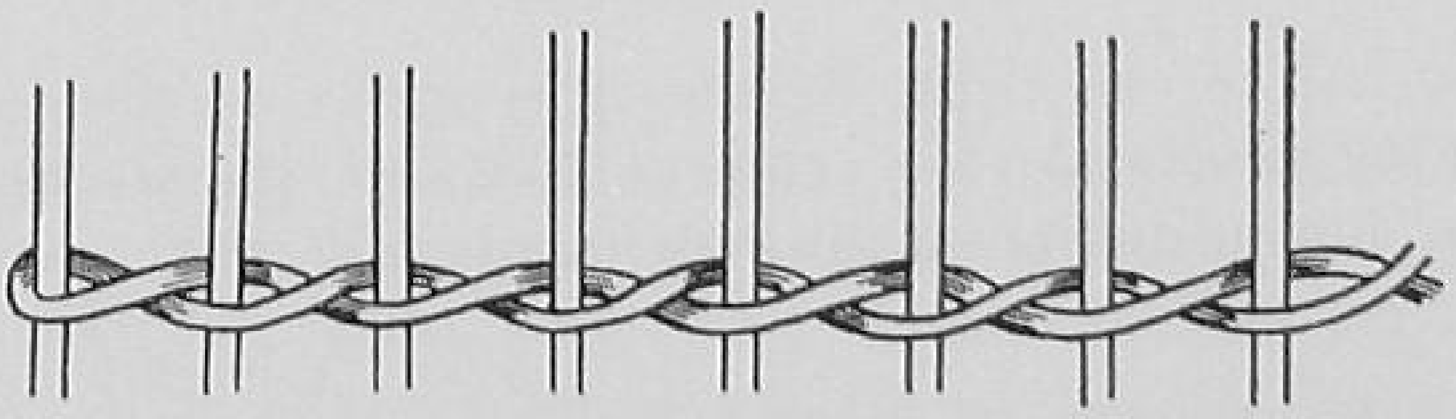


FIG. 18. Simple pairing weave using folded length of reed.

Oriental Spiral (two over two and under two)

On a basket base with a number of spokes not divisible by four this two-over-two-and-under-two weave gives a pleasing spiral effect.

One pair of parallel weavers is inserted behind a spoke and passed in front of two spokes and behind two spokes, then in front of the next two and behind the following two.

At the completion of one circuit on the basket it will be noted that the second row of weaving will commence the spiral effect. The pair of weavers is passed behind the last spoke of the set of twos that they passed in front of on the previous round (Fig. 19), and also behind the first spoke

of the set of twos that they passed behind on the previous round. Thus all the sets of spokes gain new partners. This changing, if done by leaving the left spoke and picking up the next spoke on the right, will cause

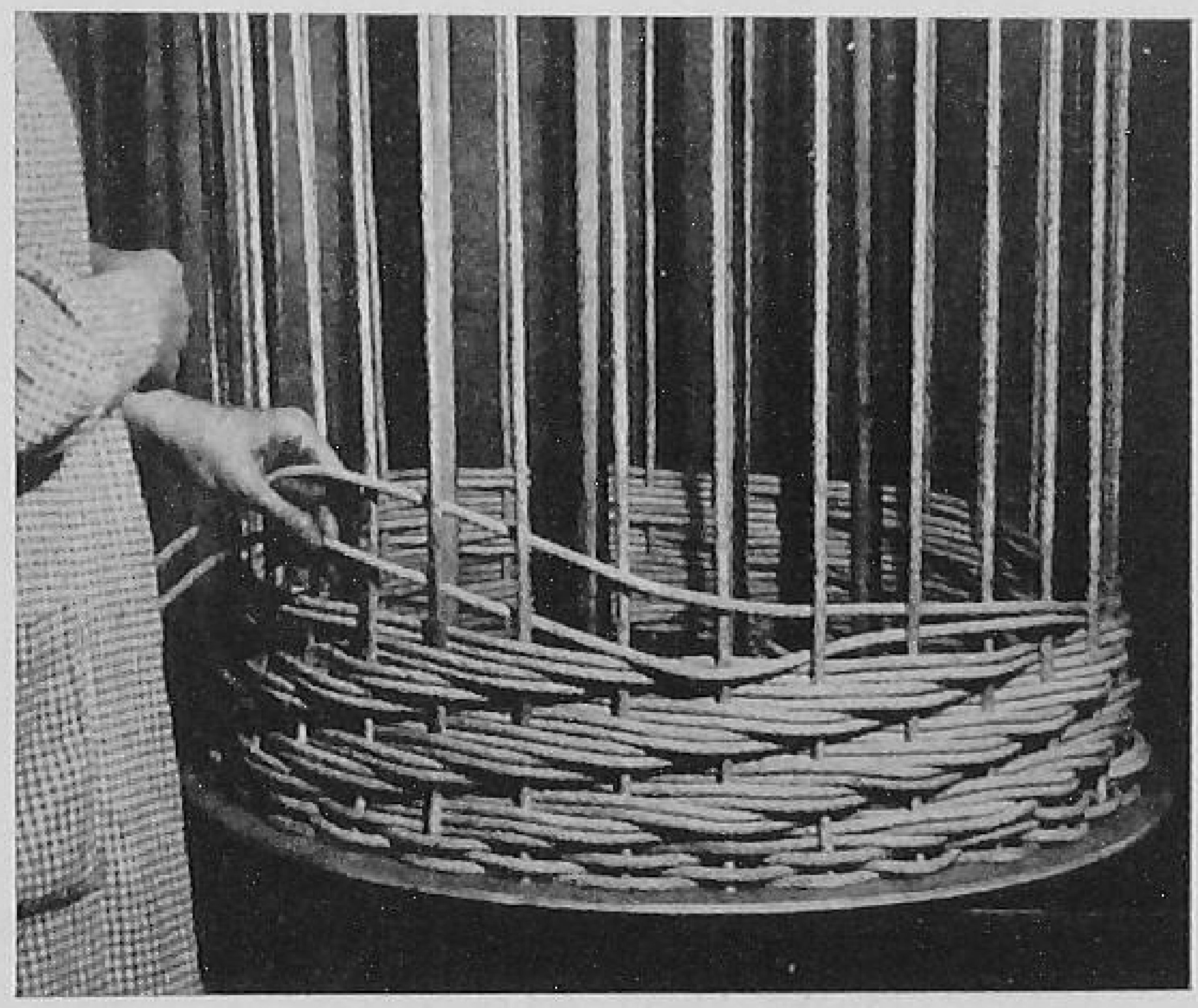


FIG. 19. Oriental spiral weave.

the spiral to coil to the right. If the right spoke of the set of twos is separated from its partner and the next spoke on the left is added, succeeding rows will cause the spiral to coil to the left.

Three-Ply Coil Weave or Triple Twist

A single weaver passes in front of two spokes and in back of a third, including three spokes in each stitch. To make the weaver alternate, each time around the basket, the number of spokes must not be a multiple of three. Single weavers are placed between the spokes in three consecutive spaces, with the ends protruding about an inch toward the inside. Then each weaver is brought, in succession, in front of two spokes crossing on top of the other two weavers, and behind the next spoke (Fig. 20). This operation is continued around the basket. Succeeding rows are completed in the same manner as the first row; and also any further rows, so that each one appears complete in itself.

One or more colored strands introduced in this weave give a barber-pole effect, as succeeding rows continue the intertwining of the colors in the

diagonal effect. This triple twist is a very compact but quickly executed weave. It is very useful, especially where a dividing line is necessary, either for strength or beauty. This three-ply weave can also be used as a

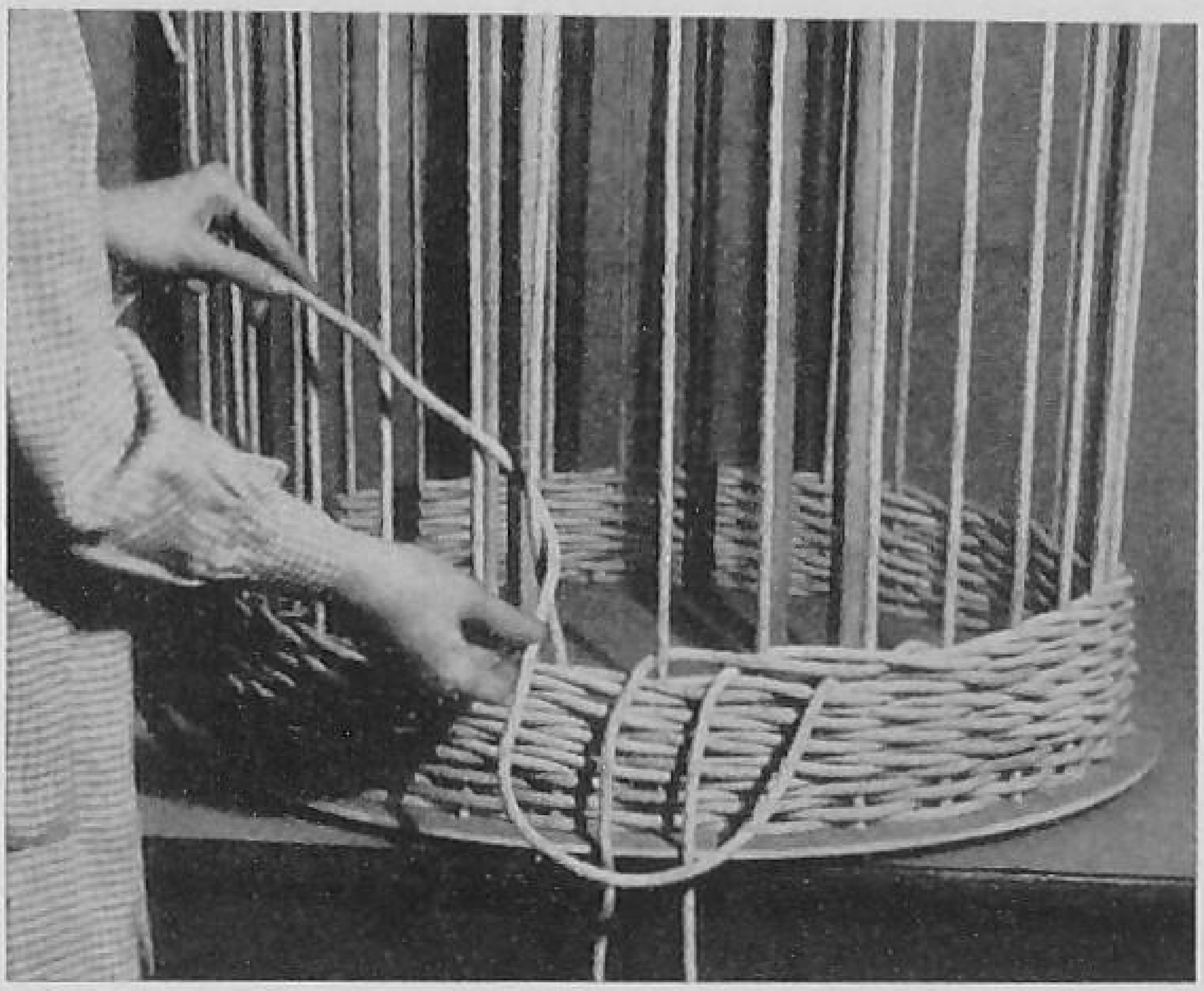


FIG. 20. Three-ply coil weave or triple twist.

border for finishing. Two parallel weavers could be used as one, making a twin triple twist. Three or four weavers, carried as parallels, could be used to make a still wider weave. In English basketry, this weave is known as "waling."

Four-Ply Coil Weave

This four-ply weave is much like triple twist, except that four single weavers are inserted between the spokes in four consecutive spaces and each weaver is brought in turn in front of three spokes and in back of one (Fig. 21).

Here the left weaver is carried in turn in front of three spokes, crossing over the other three weavers, in doing so, and behind the next spoke. As this weaver is pulled taut, the next weaver becomes the left one, and the operation is continued around the basket for as many rounds as desired. To lock the coil, finish four weavers back of four starting spokes, then carry each weaver under the coil and to the outside beside the initial weaver.

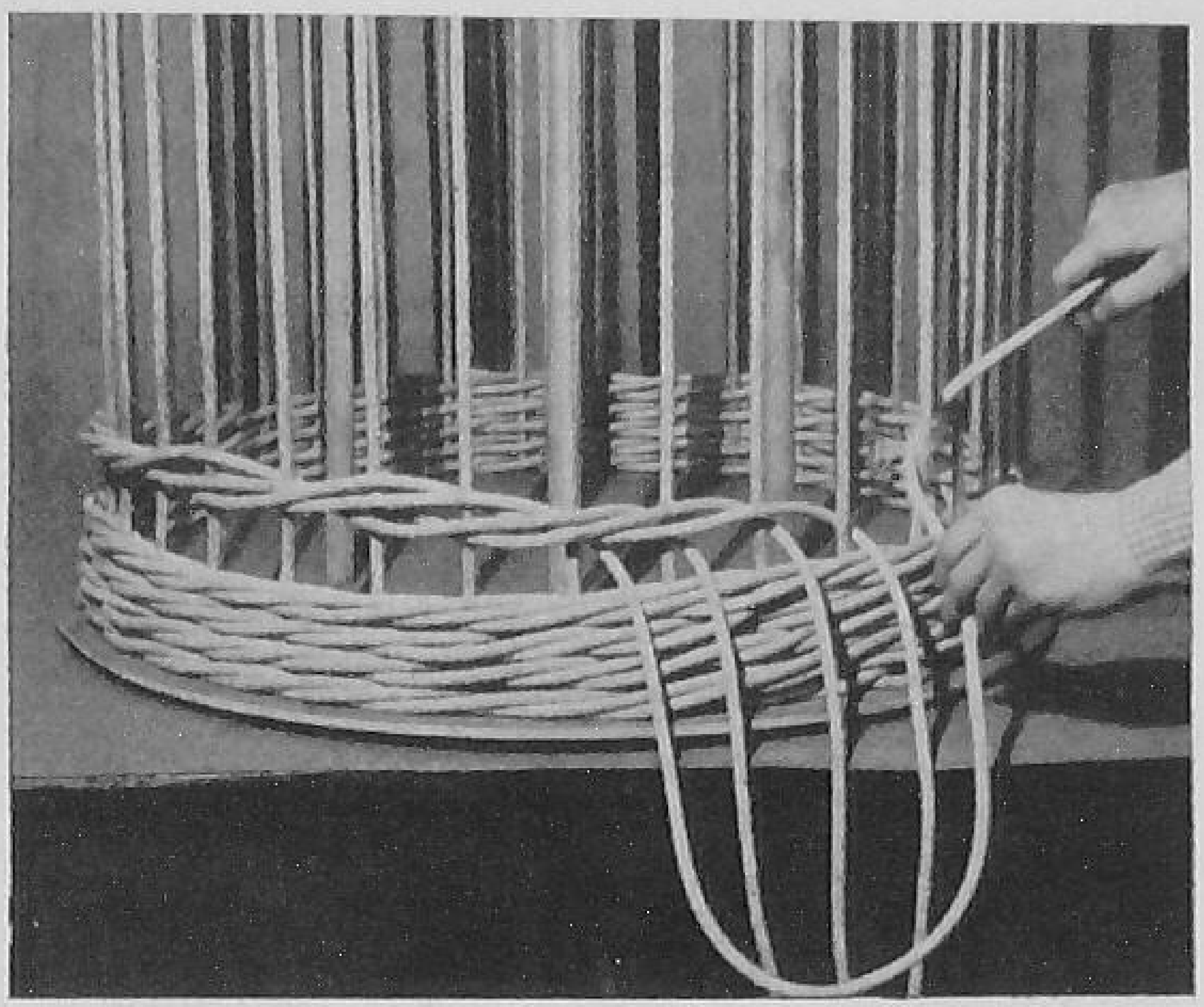


FIG. 21. Four-ply coil weave.

Five-Ply Coil

A five-ply coil could be accomplished in much the same manner as the four-ply coil except that five single weavers are inserted between the spokes in five consecutive spaces, each weaver in turn being carried in front of

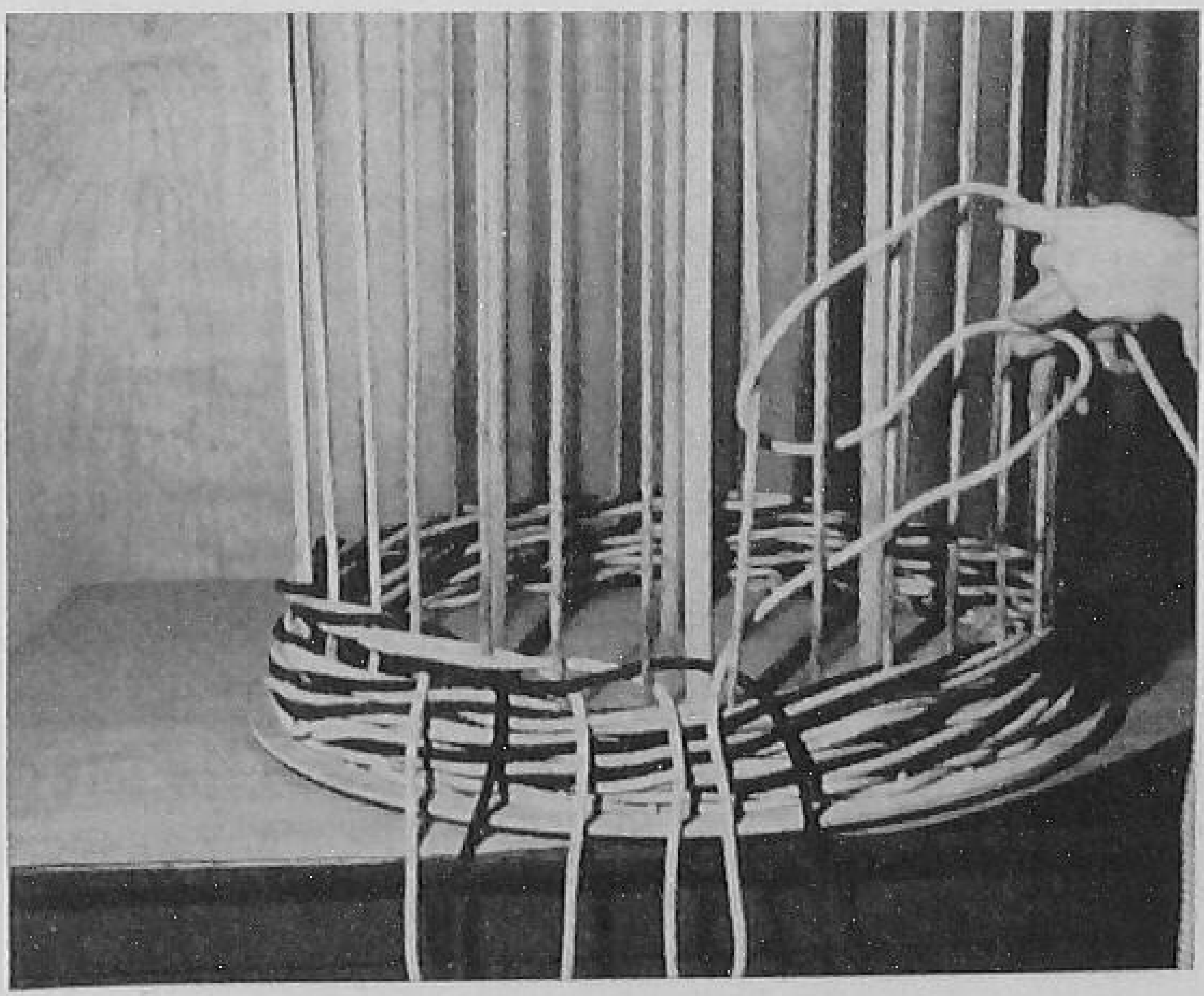


FIG. 22. Five-ply coil weave.

four spokes and in back of one or in front of three and in back of two (Fig. 22). The coil is finished by passing each weaver under the coil and to the outside beside its initial weaver.

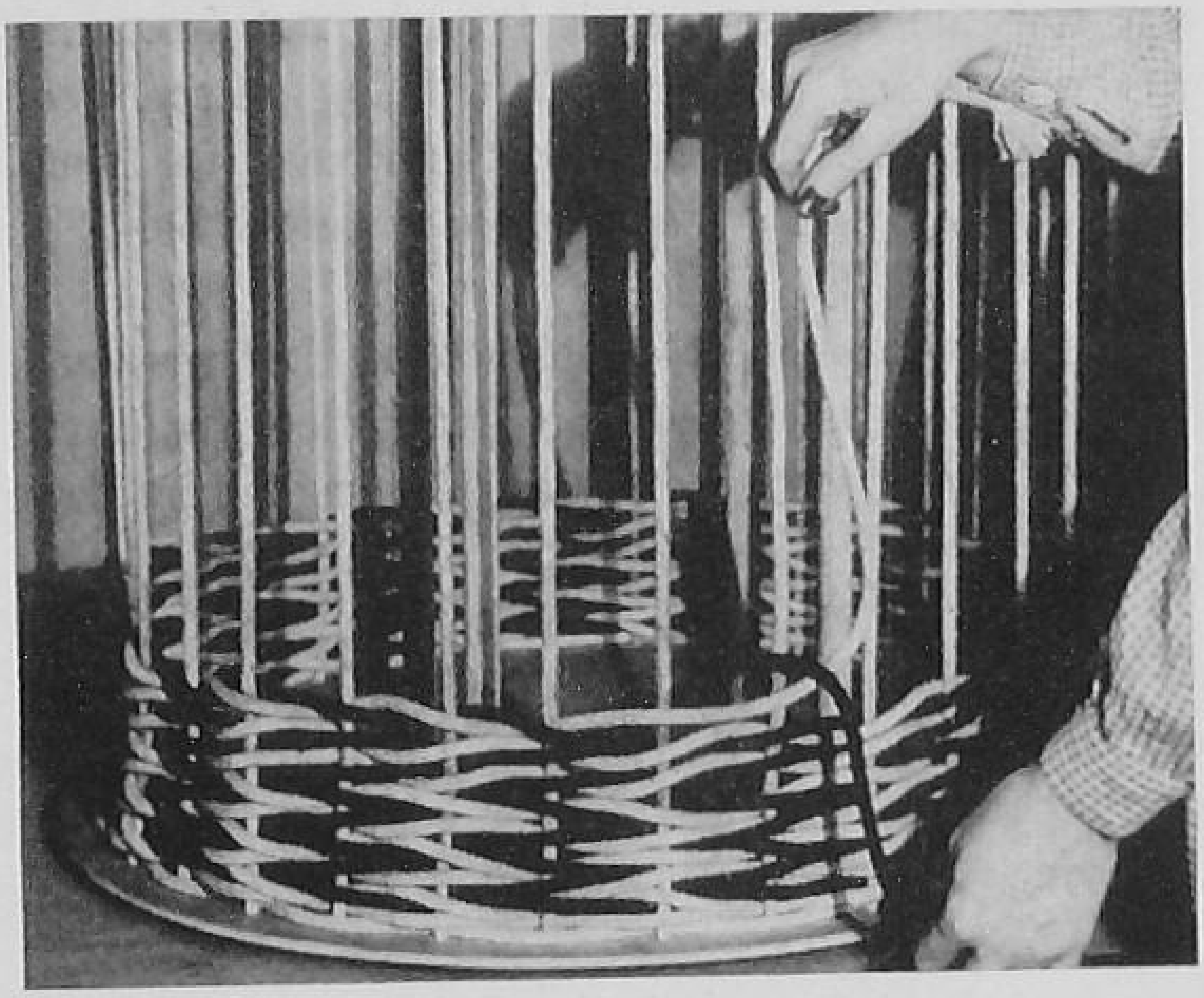


FIG. 23A. Two-tone pairing arrow.

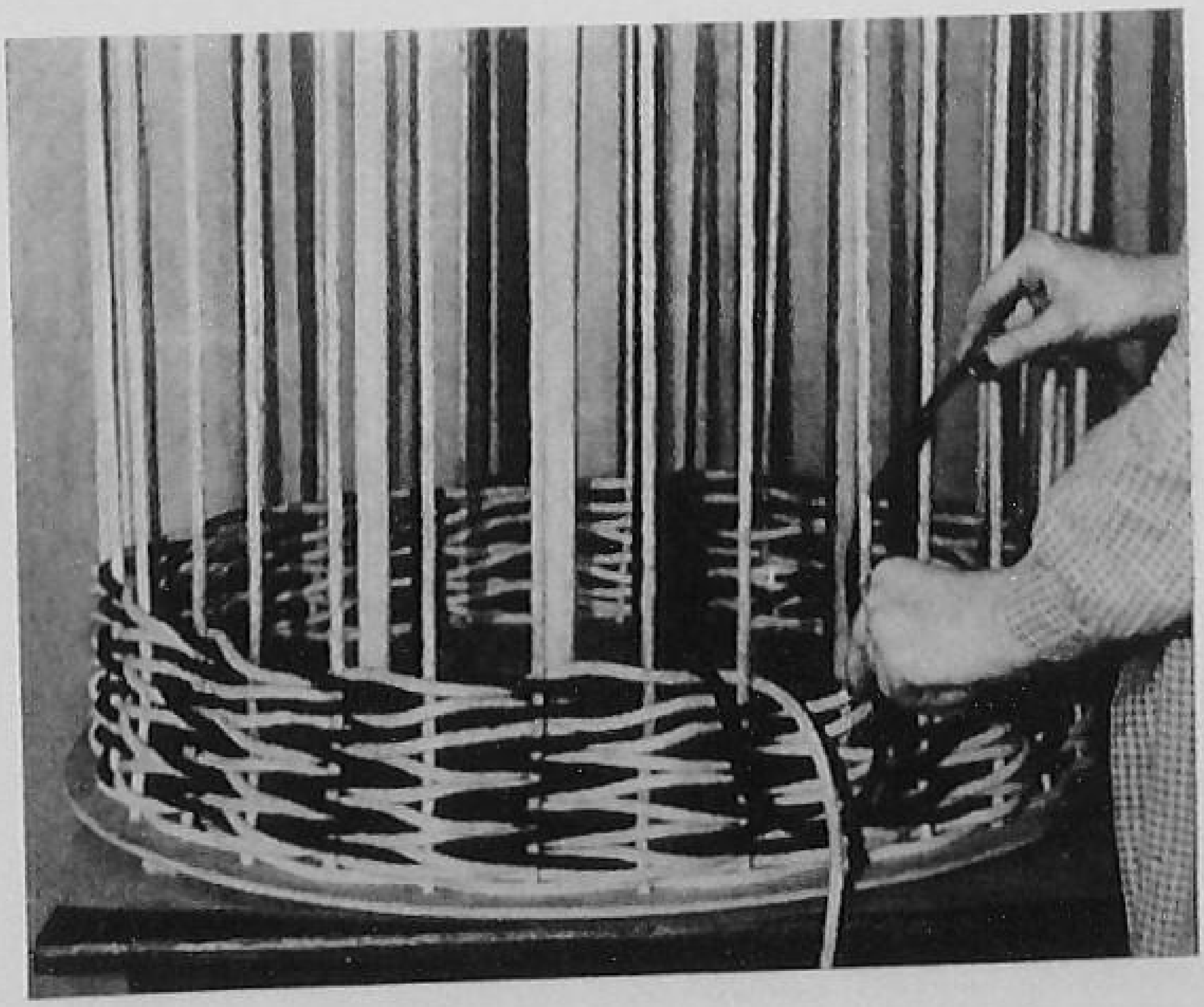


FIG. 23B. Two-tone pairing arrow.

Two-Tone Pairing Arrow

In this weave there is a regular row of pairing, using two colors of weavers, and a reverse row above it with the strands twisted in the opposite direction (Fig. 23*A*).

In the first row the left weaver is brought out from *underneath* the other weaver and crossed *over* it, before being passed behind the next spoke. In pairing on the reverse row, the weaver is brought out from *above* the other weaver and crossed *under* it before being passed behind the next spoke (Fig. 23*B*).

Any change in the manner of crossing the other weaver in either the regular or reverse row of pairing will be readily detected in the appearance of the "arrow." This arrow effect is greatly intensified by the use of highly contrasting colors.

Double Two-Tone Pairing Arrow

This weave is executed in the same manner as the two-tone pairing weave except that the two strands of each color are held parallel and used as one in weaving the alternating regular and reverse pairing rounds (Fig. 24).

Great care must be taken that the twin strands remain constantly parallel and do not twist around each other, or the flat, wide arrow effect may be confused.

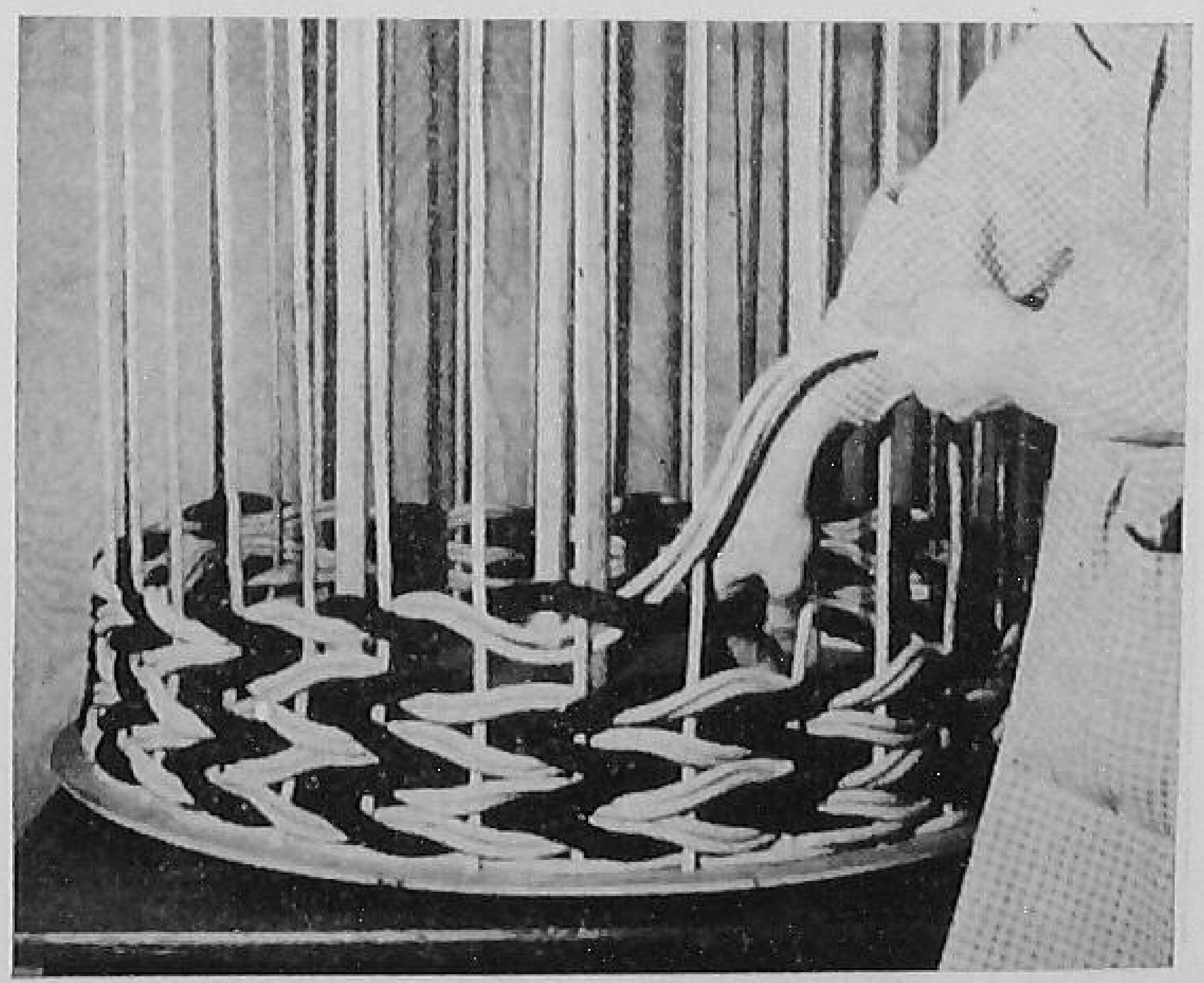


FIG. 24. Double two-tone pairing arrow.

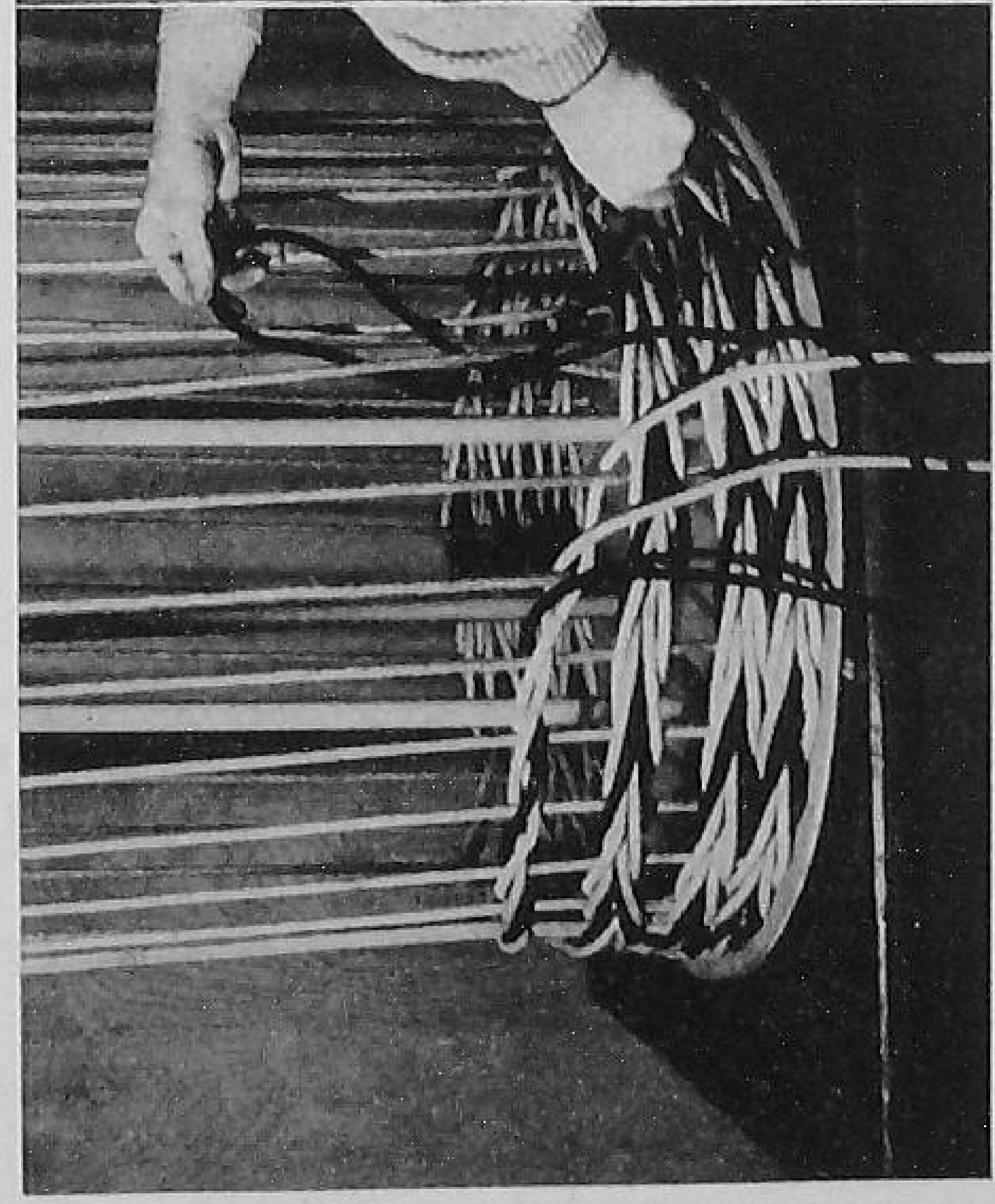


FIG. 25A. Three-ply Indian arrow.

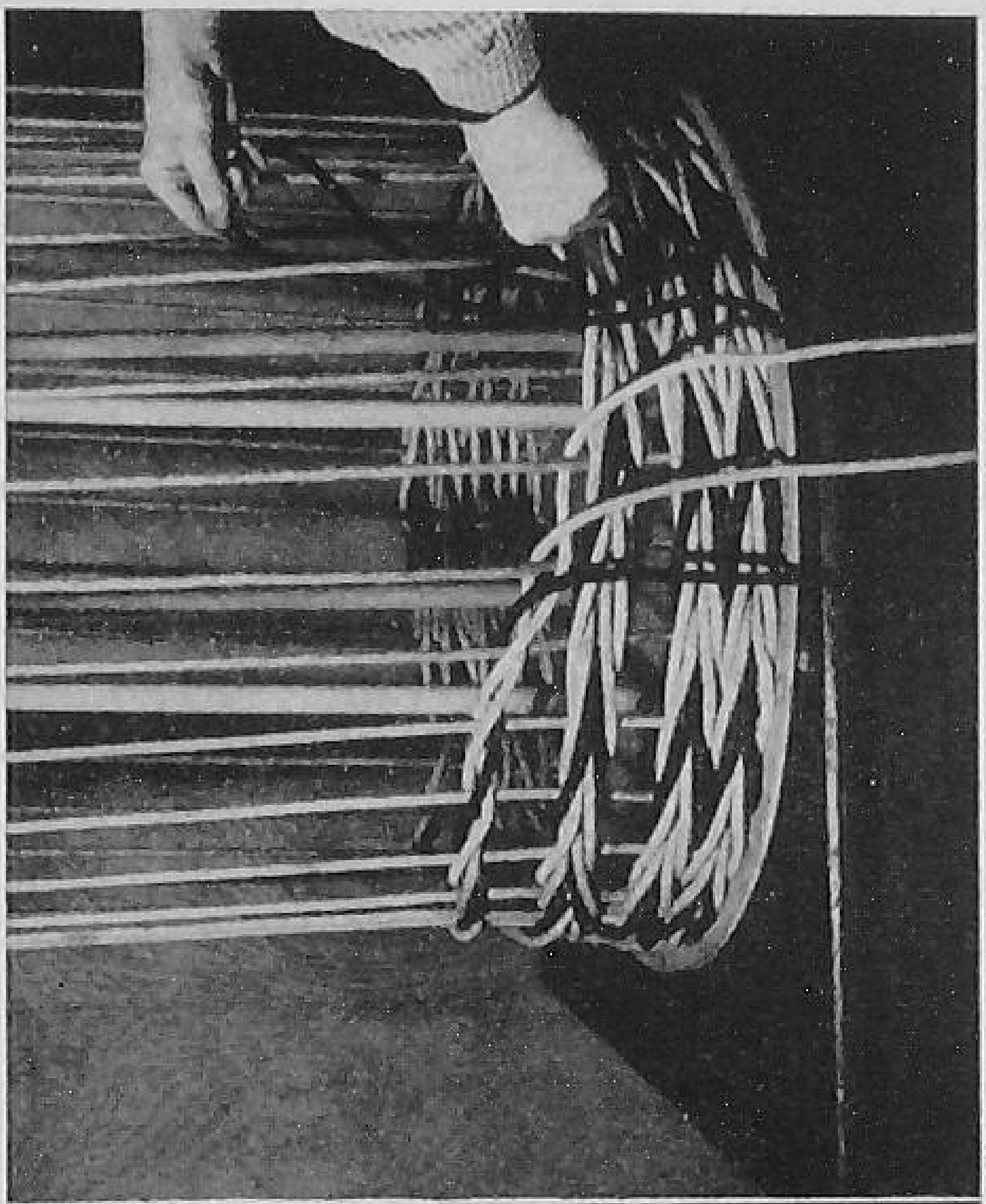


FIG. 25B. Three-ply Indian arrow.

Three-Ply Rod or Indian Arrow

If a reverse three-ply coil is added above a regular three-ply coil the opposite weavers meet in arrow points (Fig. 25*A* and 25*B*).

Two complete rounds of the basket are required to complete the arrow. Three weavers of about two and a quarter times the distance around the basket are needed for each round.

A complete round of triple-twist weave or three-ply coil is woven, in which each weaver, in turn, crosses over the other two weavers in passing in front of two spokes before passing in back of the next spoke (Fig. 25*A*).

When the initial spoke is reached the weavers are reversed for the second row. Each weaver in turn passes in front of two spokes and *under* the other two weavers (instead of on top as in the first row) and behind one spoke (Fig. 25*B*). This procedure produces a convergence of weavers at each spoke and thus makes the arrow. The second round of weaving is continued until the initial spoke is reached again. If the basket maker desires several rows of arrows, this operation is repeated to produce the desired rounds—first a round of regular three-ply coil and then a reverse three-ply coil to complete the arrow.

In order to close the arrow the row of reverse twist is continued until the initial spoke is reached. The right-hand weaver is passed in front of two spokes and under the two top weavers of the second (reverse) row, to the inside of the basket. This operation is repeated with the next weaver, and again with the third, and thus the arrow is completed.

It is necessary to follow each step carefully, as a mistake will be readily detected in the appearance of the arrow.

Four-Ply Rod or Indian Arrow

A four-ply rod arrow is woven in a manner similar to that used for the three-ply rod arrow, with the following difference. Four weavers are used, and each one is passed in front of three spokes *over* the other three weavers and in back of one spoke. When the initial spoke is reached, the weavers are reversed by passing the right-hand weaver in front of three spokes, *under* the other three weavers, and in back of one spoke (Fig. 26). The next round is a repeat of the first regular circuit followed by a reverse row and so on until the desired number of arrows are woven.

The arrow is closed by passing the left weaver in front of the spokes and under the three top weavers of the second row to the inside of the basket.

This operation is repeated with each of the three remaining weavers.

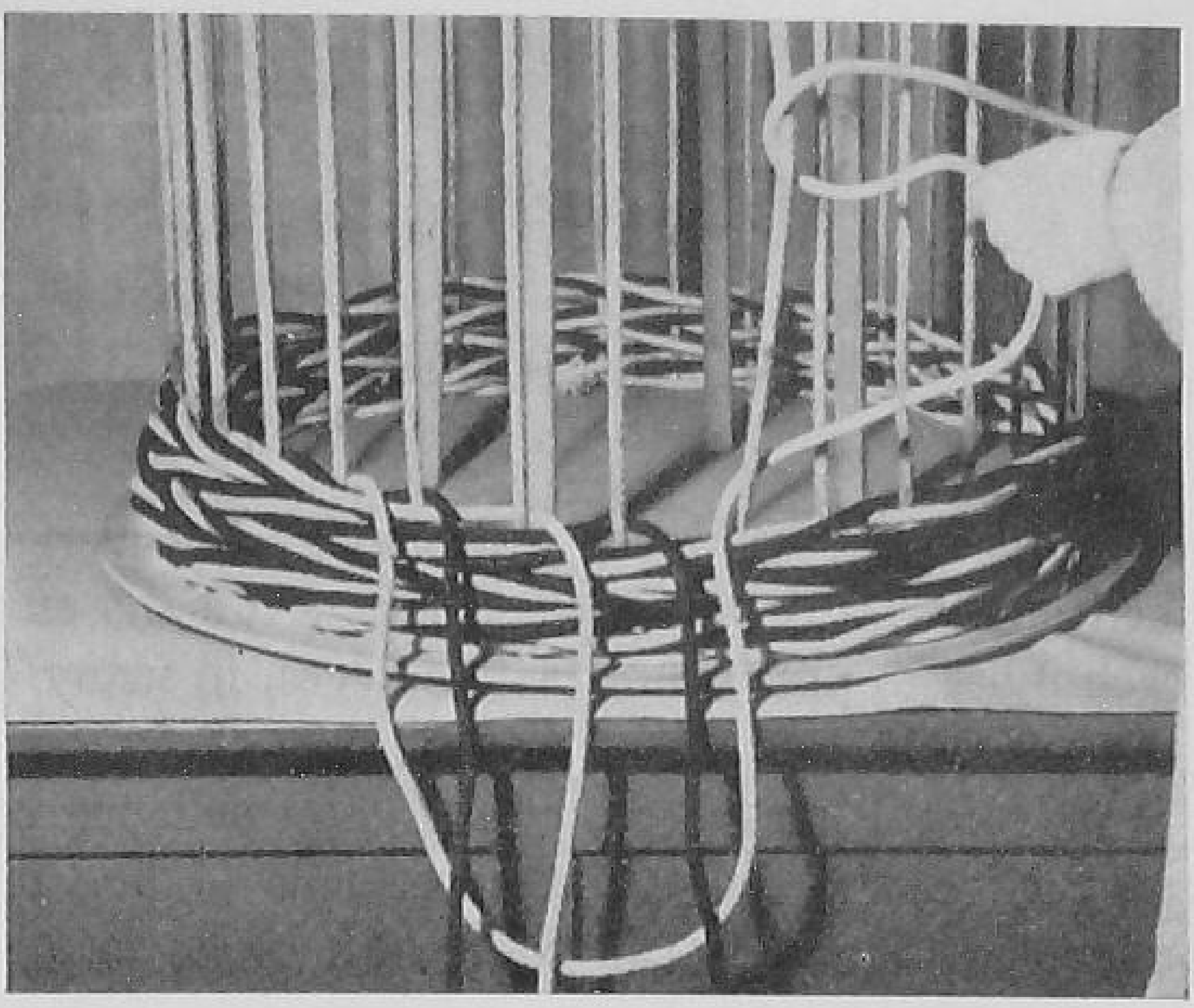


Fig. 26. Four-ply Indian arrow.

The four-ply rod arrow is heavier than the three-ply rod arrow, and is more appropriate for wastebaskets, jardinieres, window boxes, and other projects requiring strength, both in appearance and in use. Either the three-ply rod arrow or the four-ply rod arrow is often used as a dividing line between two different kinds of weaves.

Chapter V

REED BORDERS

The kind of border used on woven reed articles is governed partly by the type of article and the weave used. Borders are the ends of spokes woven into each other to produce attractive edges, in many cases adding strength to the articles.

A border is of great importance, since it may enhance or lessen the attractiveness of a basket. Dainty baskets, made of fine reed, may be finished with borders of one or two rows with single or double spokes (these extra spokes often being added just for border effect). Larger and stronger baskets made of heavier reeds or baskets subject to a great deal of handling require borders of three or more rows of weaving. For the kind of handwork done in school, the borders most commonly used are those made of the bent spokes. These spokes are finished in various loops,

FIG. 27. Base border wrapped with cotton cord. Various borders.

twists, and turns that clearly define the basket edge. There are three kinds of borders—open, closed (or rolled), and braided. The type chosen for any basket should be in keeping with its texture and design (Fig. 27). After the completion of three or four baskets, each with a different border, it will be easy and natural to decide upon the most appropriate border for other baskets of one's own designs. For once a basket maker knows the different weaves and borders, any number of shapes and sizes of baskets with their appropriate borders will suggest themselves to him.

Before the border is begun the spokes should be thoroughly soaked to render them pliable. As the work proceeds, it will probably be necessary to soak the spokes again to prevent them from breaking or splitting. This can be done by soaking a sponge and pulling each spoke slowly through the folded sponge.

If there seems to be too wide a space between spokes (on large trays or baskets) an extra spoke may be inserted beside each spoke, making pairs of spokes for a closer border. These new spokes are soaked and one end dipped in liquid glue before being added to the basket. To make an even effective basket border these added spokes must each be on the same side of the original spoke, and be pushed in far enough to insure their adding to the strength of the top edge of the basket.

Open Borders

Open borders are made by bending the spokes over one another in loops. They may be used to finish baskets made of either wicker, pairing, or triple weaves. The scallop or open loop is the simplest to work, but it is wise not to adopt this for baskets that are intended for hard wear. However, its lacy appearance is splendid for finishing dinner mats, glass holders, vases, cake trays, and fancy flower baskets.

Open Border I

Spokes should be long enough to make the desired curve to the edge, plus enough to insert down into the woven section. The loops should be the same height and of uniform shape. To make the weaving of the border simple make one loop first, inserting the end of the spoke well down into the basket, and then measure the length required. Before proceeding with the border cut all the spokes to this measurement, with a slanting end. To make the loops (Fig. 28*A*), pass each spoke behind the next spoke to its right and insert the end down into the weaving, keeping the end close to that spoke, on its right.

Open Border II

For Open Border II spokes should be longer than for Open Border I, because the curve is longer. These loops must also be of uniform height and shape.

Bend one spoke, pass it behind the two spokes to its right, and insert it down into the weaving to the right of the second of the two spokes, to determine the desired length (Fig. 28*B*).

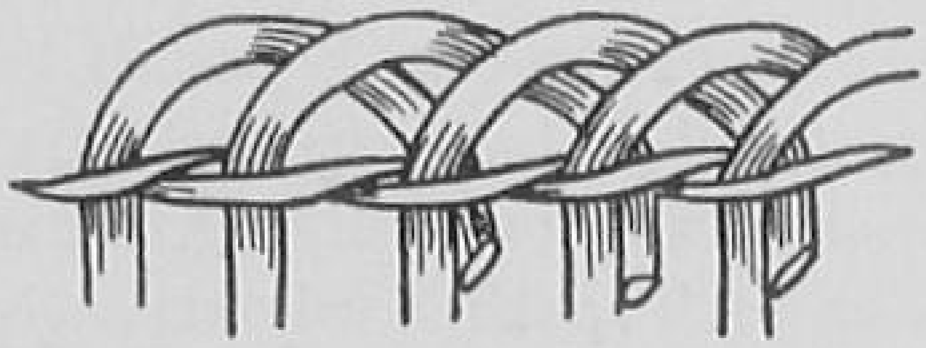


FIG. 28A. Open border I.

FIG. 28B. Open border II.

Cut all spokes to this measurement, with slanting ends.

Pass each spoke in turn behind the two spokes to its right and insert it down into the weaving to the right of the second of the two spokes.

A scratch awl or other pointed tool may be needed to open the weave sufficiently to allow the final spokes to be inserted. This method makes a very compact border, which adds to the strength of any woven piece.

Open Border III

A border with a very lacy appearance can be woven if several rows of pairing weave are used as the final rounds of a basket.

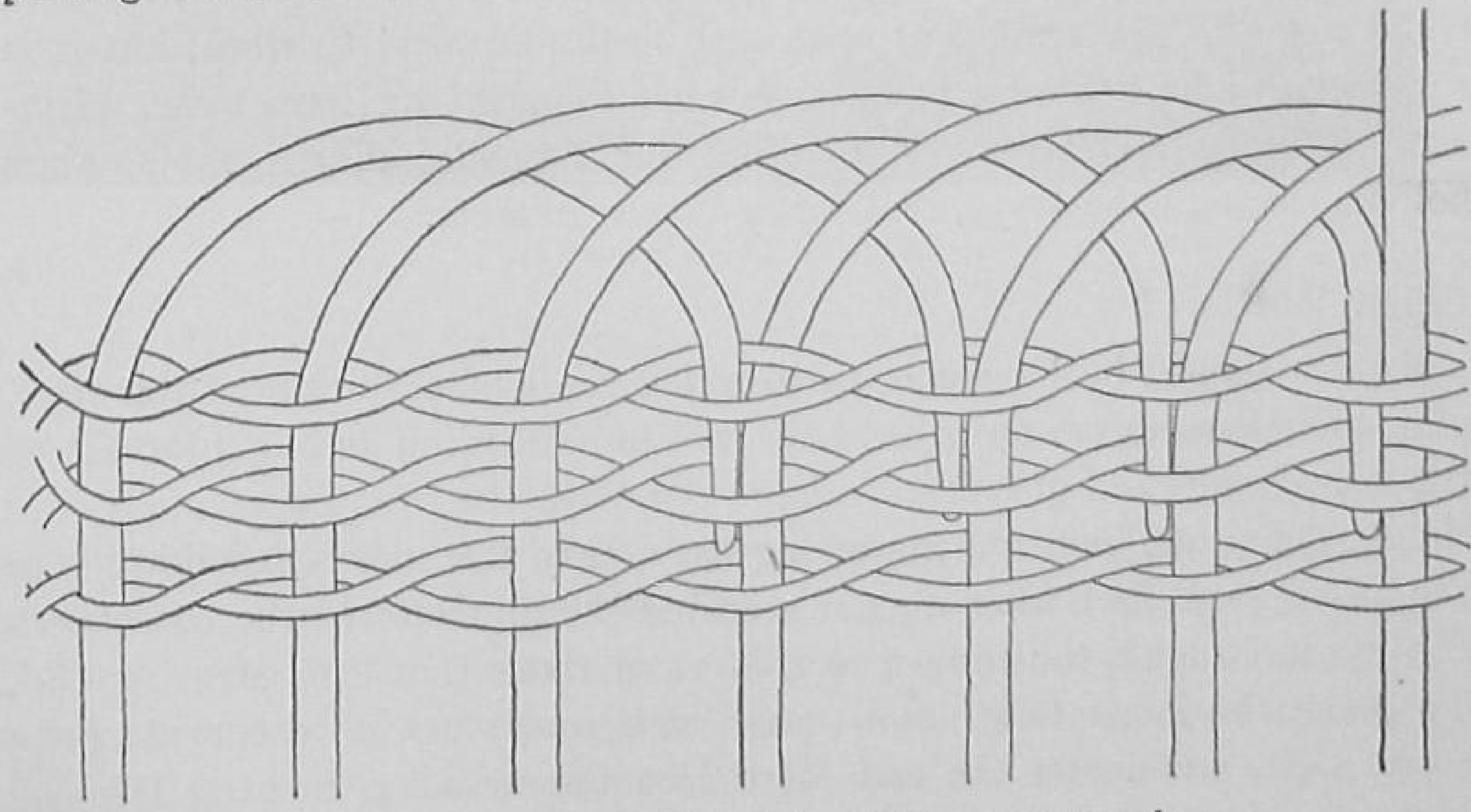


FIG. 29. Open border III with pairing weave rounds.

Bend each spoke in a loop, pass it behind the two spokes to its right, and insert it down into the weaving on the left of the third spoke to the right (Fig. 29).

Open Border IV

For hanging baskets or those used as centerpieces in which containers for cut flowers are inserted, the open border IV produces a very desirable finish for the edge of the basket (Fig. 30).

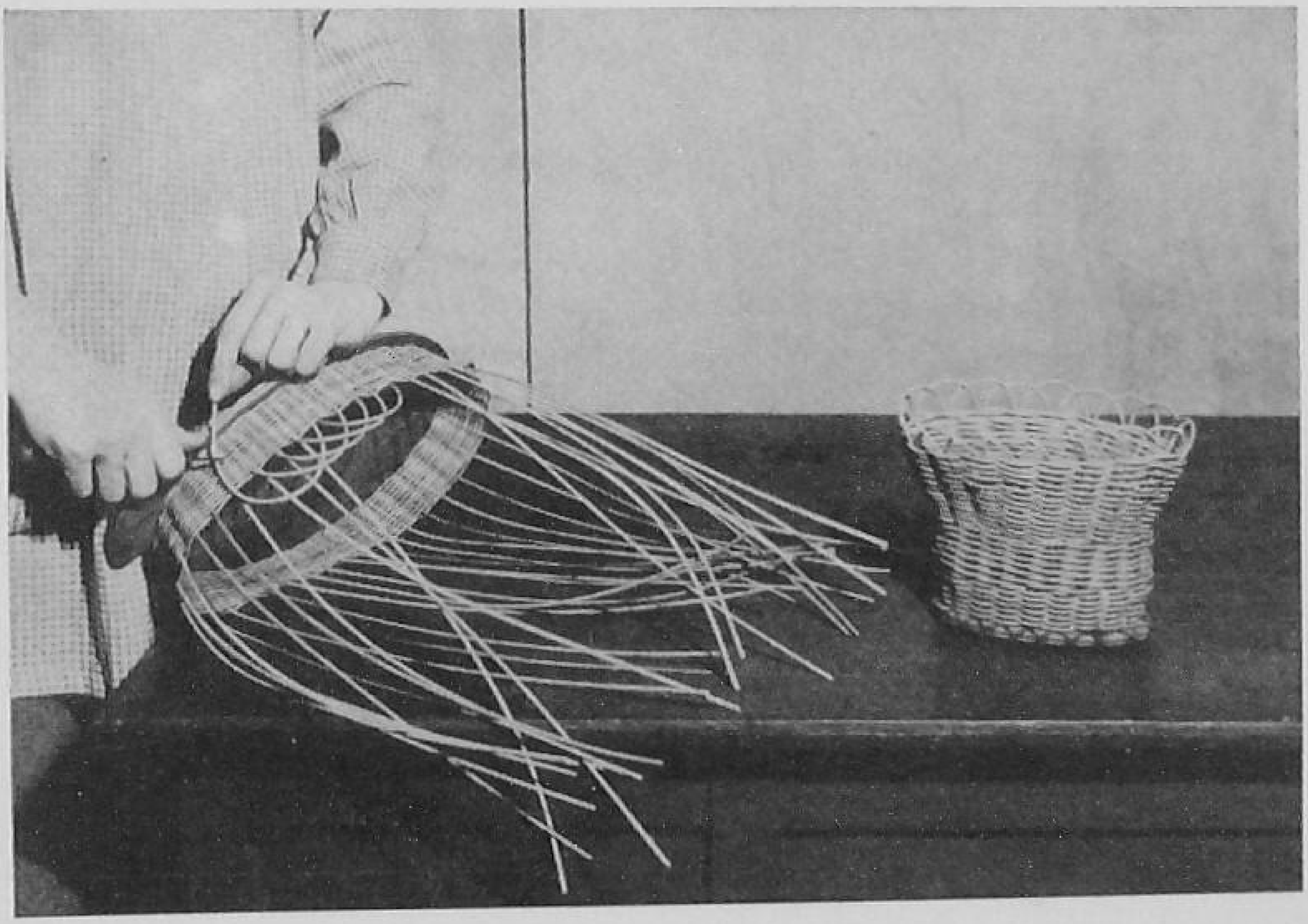


FIG. 30. Open border IV.

Bend each spoke, in turn, over in a loop, behind the next three spokes to the right, and insert the slant end into weaving beside fourth spoke at right.

It will be noticed that these long loops have a tendency to curve toward the center of the basket, thus decreasing the diameter of the top opening. On baskets made as flower pot holders or those that are woven around a glass fish bowl or other hollow spherical object, these loops curving toward the center often hide the edge of the container and prevent it from slipping out.

Outer Loop Border

This border makes a very lacy appearing outside surface on a flower pot holder or a hanging basket.

It is understood that the basket sides have been woven to the desired height before the outer loop border is begun. Also that all ends of the weavers are cut on the slant and turned down beside the spokes on the inside of the basket.

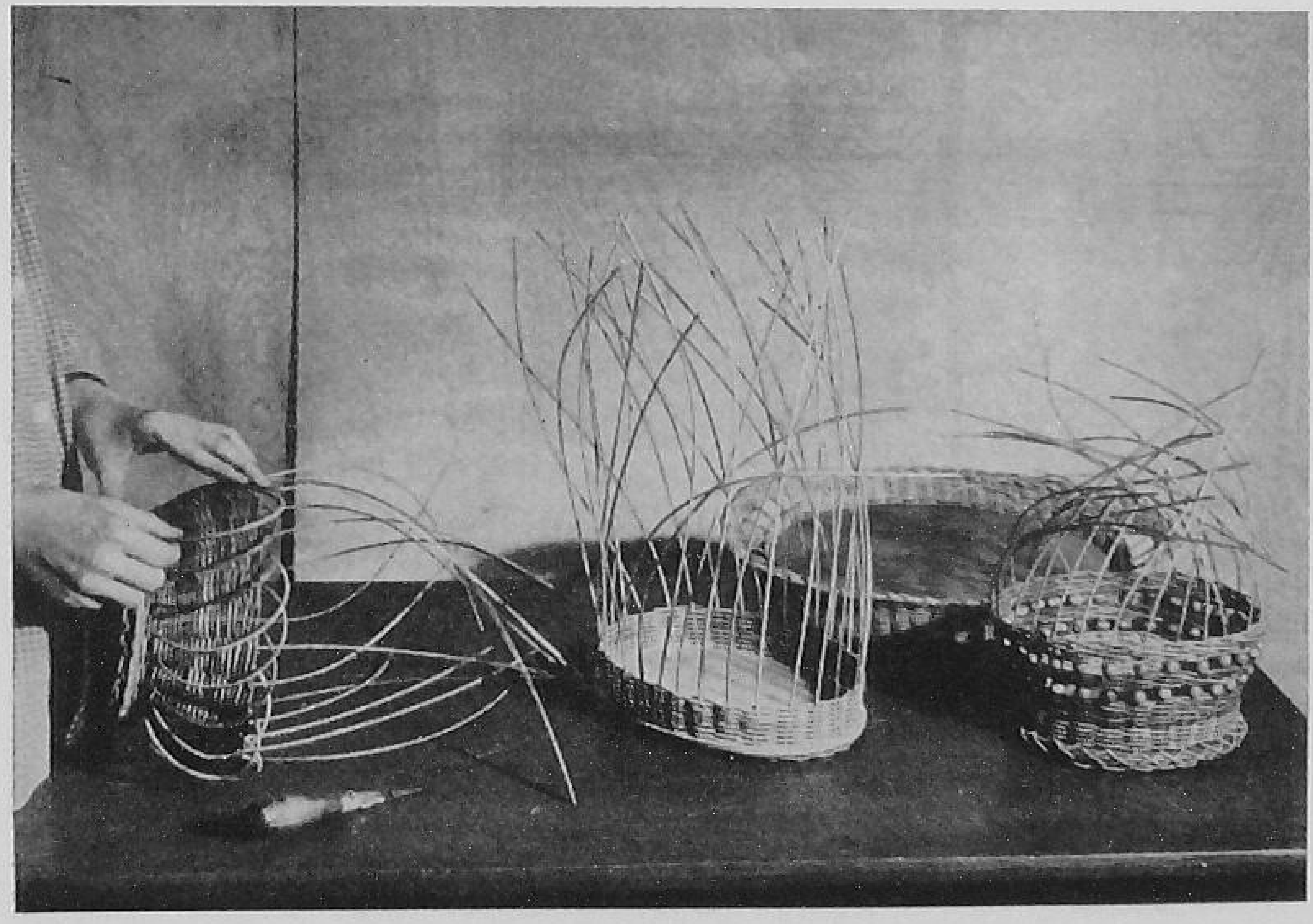


FIG. 31. Outer loop border.

Step 1. The edge is finished by passing each spoke, in turn, to the right and behind two spokes. This brings all the spokes to the outside of the basket.

Step 2. Regulate the top edge to the same size and height all around.

Step 3. Cross the ends of the spokes to the left over one or two spokes (Fig. 31), depending on the desired size of the outer loop.

Step 4. The spoke ends are cut on the slant and inserted in weaving alongside of the upright spokes so that they rest at least one fourth of an inch against the spokes.

Additional Spokes

When weaving large baskets, lamp bases, and other circular projects, it is often necessary to insert additional spokes; otherwise the weaving circuits will not be uniform and the work will be crude.

Step 1. Measure the distance from the weaving to the loose end of the original spoke and cut the additional spokes 1½″ longer.

Step 2. Cut spoke end on an angle so they will slide in easier than if cut straight across or blunt.

Step 3. Insert the awl next to an original spoke and between the strands of weaving; work it back and forth gently and withdraw it.

Step 4. Force the slant end of the additional spoke ¾ to 1½″ into the hole thus formed. If a single additional spoke is used with each original spoke it should be inserted on the same side of the original spoke consistently around the basket. If two additional spokes are used at the location of each original spoke, one is inserted on either side of the original spoke. As a general rule when additional spokes are added several rounds of simple pairing or other close weave are completed, in which the spoke groups are treated as one.

In order to produce a more uniform foundation, the spoke groups are then separated and simple pairing, or a more open weave is used in which the spaces between the additional spokes and the original spokes are adjusted.

Very lacy and entwining edge finishes may be produced where additional spokes have been inserted. First the original spoke is turned down in any of the open border sequences around the basket. Next, either the left or right additional spoke is turned down in the same or another open border sequence. Finally the remaining additional spoke, if two were used, is turned down in the same, or another open border, sequence.

Closed Borders

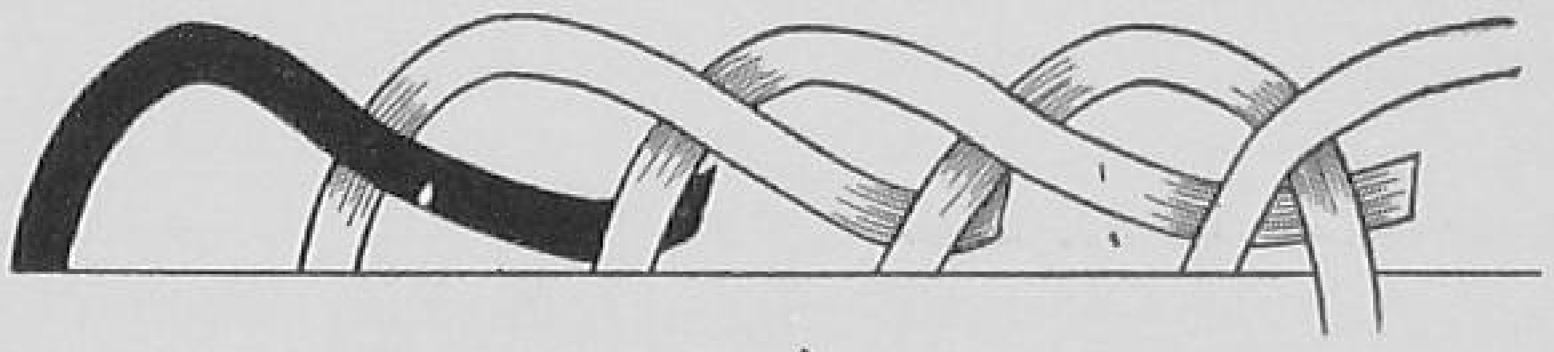
In closed borders the spokes are twisted over one another and their ends firmly locked beneath the border. The simplest type of closed border is a single turning of the spoke ends over one another.

Closed Border I—Single Twist

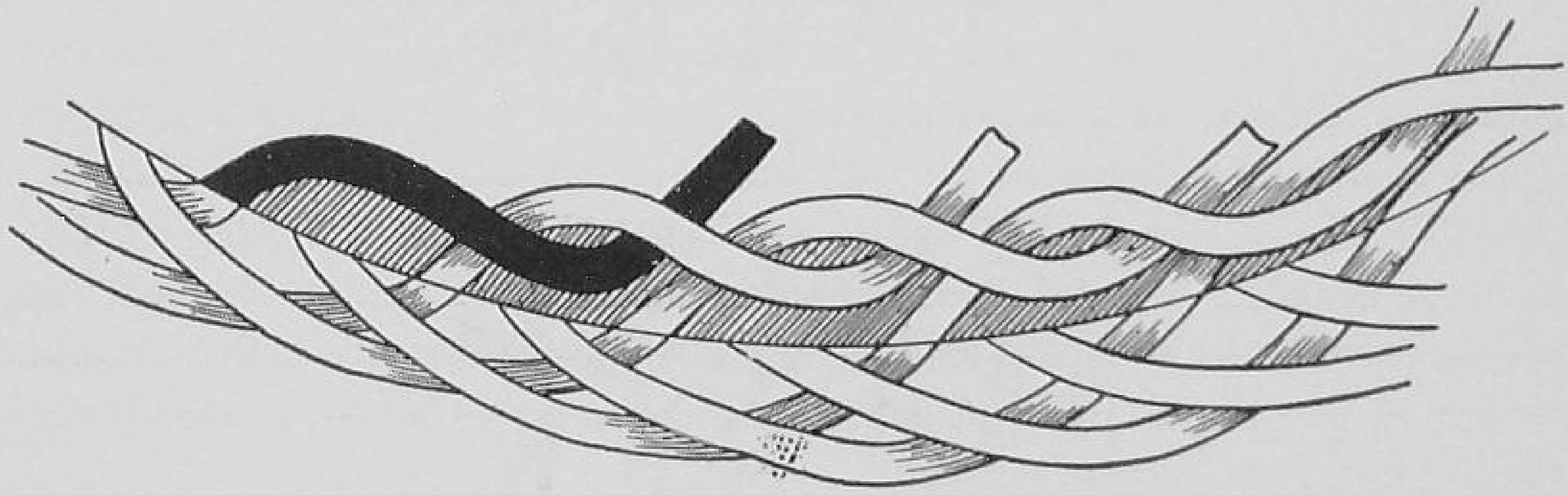
Carry each spoke in front of the first spoke to its right and in back of the second spoke to its right, and to the inside of the basket (Fig. 32*A*). The motion is "over a spoke and in."

The single twist may be used alone as a border, or the spoke ends

remaining after the completion of any other closed or any braided border may be turned to the inside in a single twist (Fig. 32*B*). In more substantial borders, such as those that are described in the following pages, the spokes are twisted in and out of several others.



A



B

FIG. 32A & B. Showing closed border I used on the inside of other borders.

Closed Border II

Each spoke should measure between 3½″ and 5″ depending on the distance between spokes. Two rows of weaving are required.

First Row. Pass each spoke behind the spoke to its right and then to the outside of the basket.

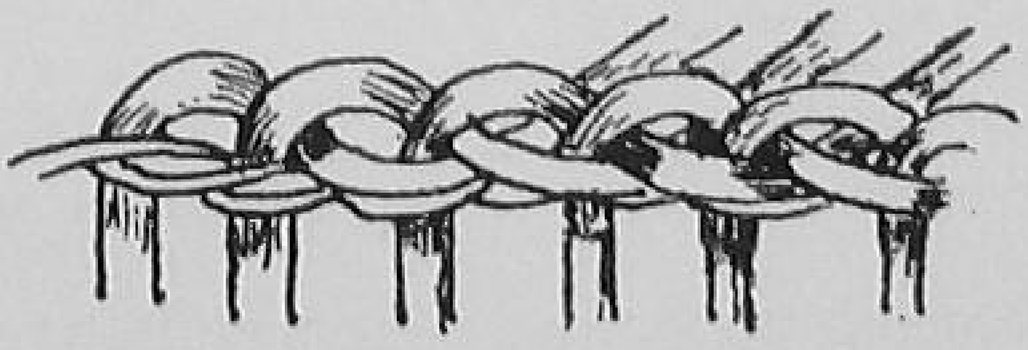


FIG. 33. Closed border II.

Second Row. Pass each spoke in front of the spoke to its right, *under* the row already woven, and to the inside of the basket (Fig. 33).

A scratch awl or other pointed tool may be needed to enlarge each loop made in the previous row so that the end of the spoke may be inserted under the row already woven.

Closed Border III

Spokes should measure between 4½ and 6½″. Three rows of weaving are required.

First Row. Pass each spoke in front of the spoke to its right, and then to the *inside* of the basket (Fig. 34*A*).

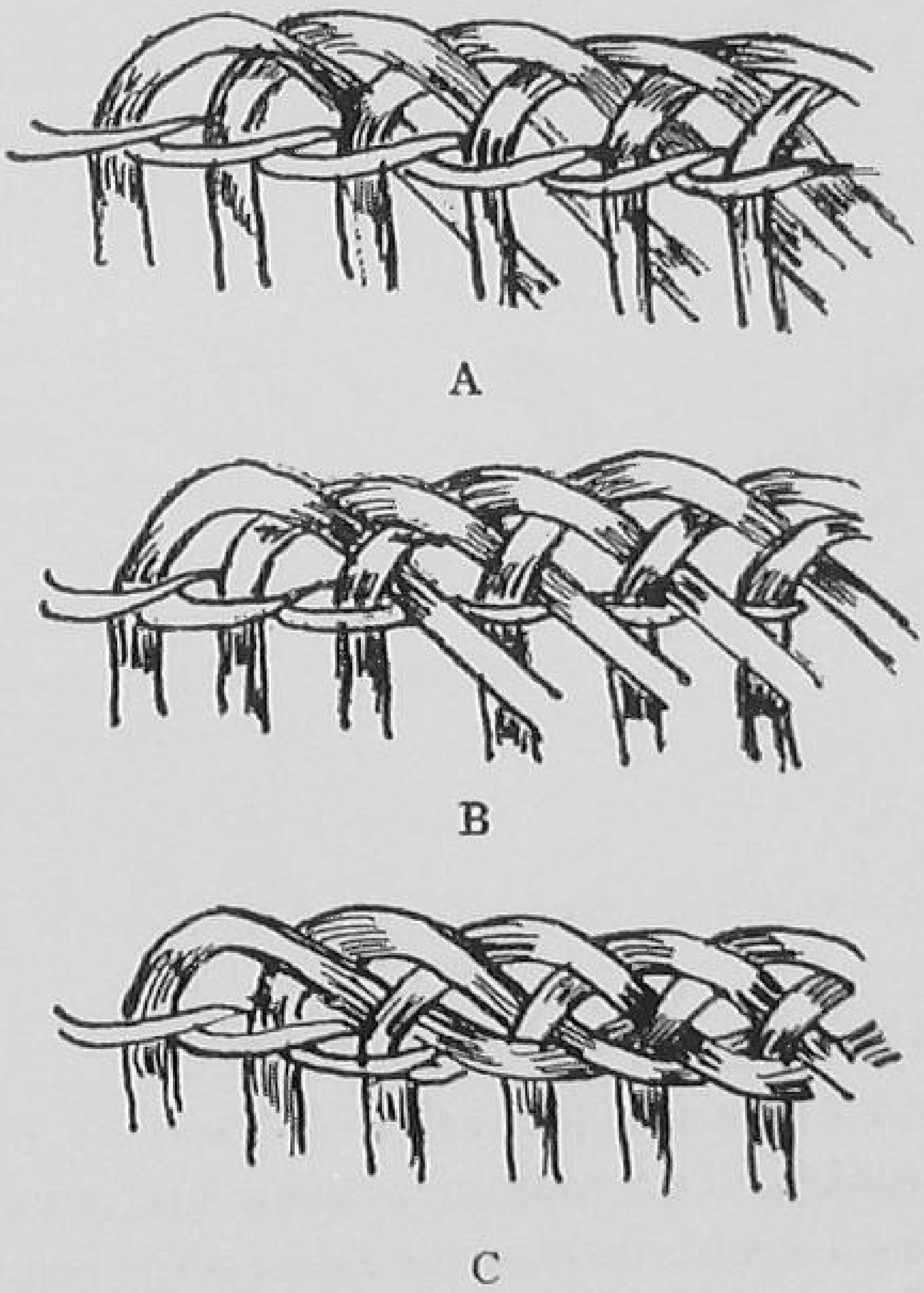


Fig. 34. Closed border III.

Second Row. Pass each spoke behind the second spoke to its right, under part of the border already woven, and to the *outside* of the basket (Fig. 34B).

Third Row. Pass each spoke in front of the third spoke to its right, under part of the border already woven, and to the inside of the basket (Fig. 34*C*).

Closed Border IV

Spokes should measure 5″ if spaces between spokes are under ¾″, and 8″ if the spaces measure 1″. Four rows of weaving are required.

First Row. Pass each spoke behind the spoke to its right, and to the outside of the basket (Fig. 35*A*).

Second Row. Pass each spoke in front of the second spoke to its right, under the row already woven, and to the inside of the basket (Fig. 35*B*).

Third Row. Pass each spoke behind the third spoke to its left, under part of the border already woven and to the outside of the basket (Fig. 35*C*).

Fourth Row. Pass each spoke in front of the fourth spoke to its right, under part of the border already woven, and to the inside of the basket (Fig. 35*D*).

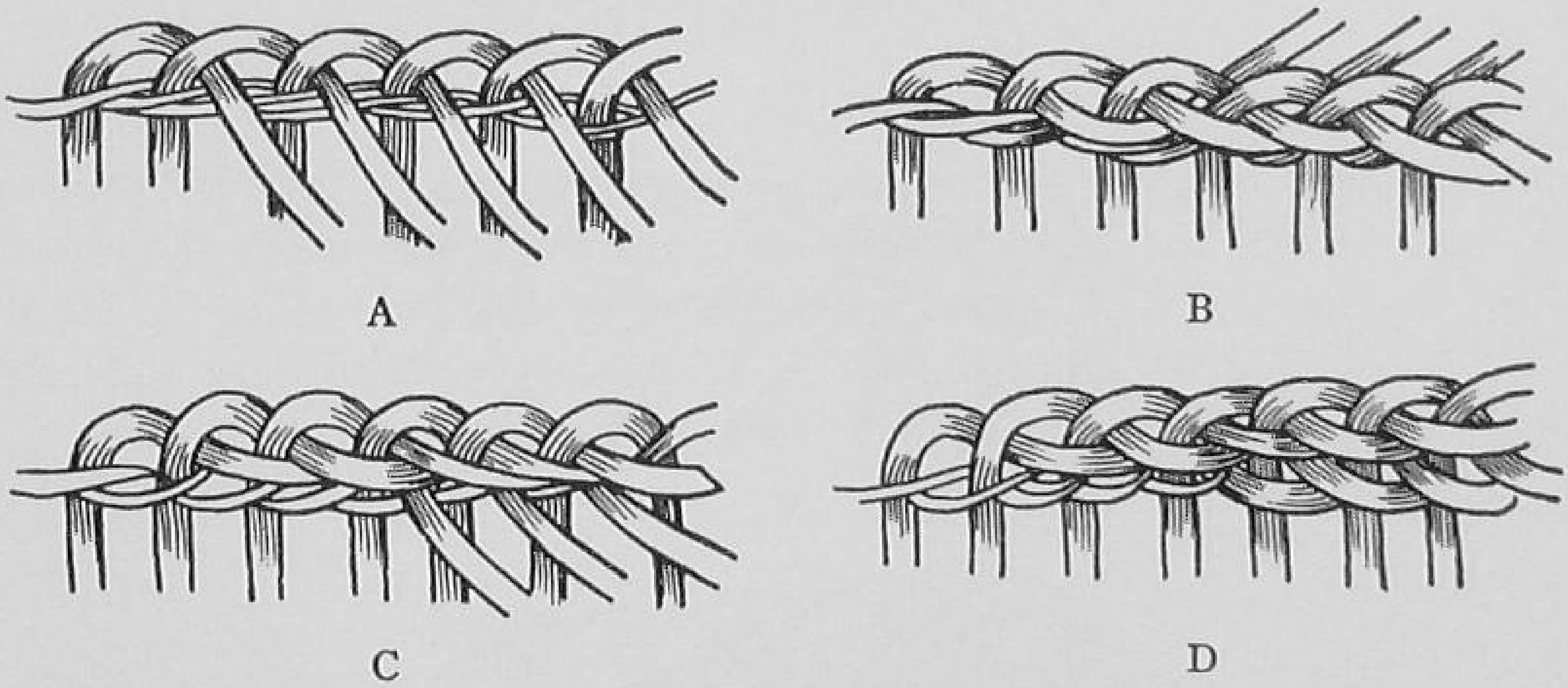


FIG. 35. Closed border IV.

This border is especially adaptable for large baskets and may be elongated by passing behind and in front of two spokes instead of one spoke for each row.

Closed Border V

Carry each spoke in turn behind the first spoke to the right, in front of the next three spokes to the right, and to the inside of the basket (Fig. 36*A*).

These closed borders afford many variations.

Each spoke may pass under several spokes, over several, and in; or over one, under one, over one and in; or over one, under two, and out to the outside of the basket to form a rustic border with the spoke ends cut on the outside (Fig. 36*B*).

It is always advisable to try out various combinations for a basket, selecting that which seems suitable to the basket texture and use.

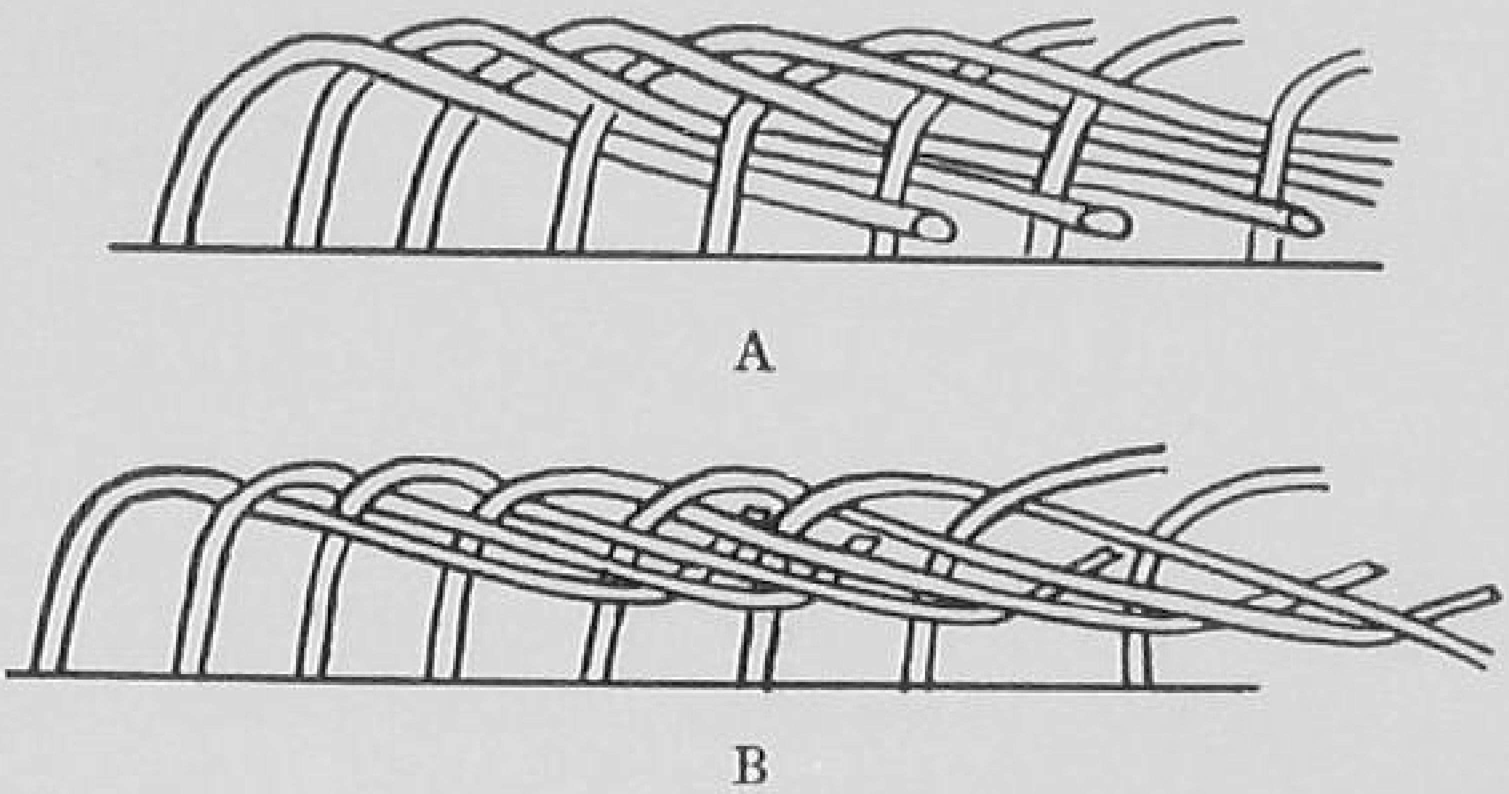


FIG. 36A & B. Spoke ends on outside, closed border V.

Closed Border VI—Rolled Edge

Carry each spoke in succession over several spokes to the right and to the inside of the basket (Fig. 37). To fasten the spokes inside this rolled edge, the simple twist of over a spoke, under a spoke, and in, to the inside of the basket serves quite well. Fig. 37 shows the rolled edge with the spoke ends terminating in a simple twist on the inside of the basket.

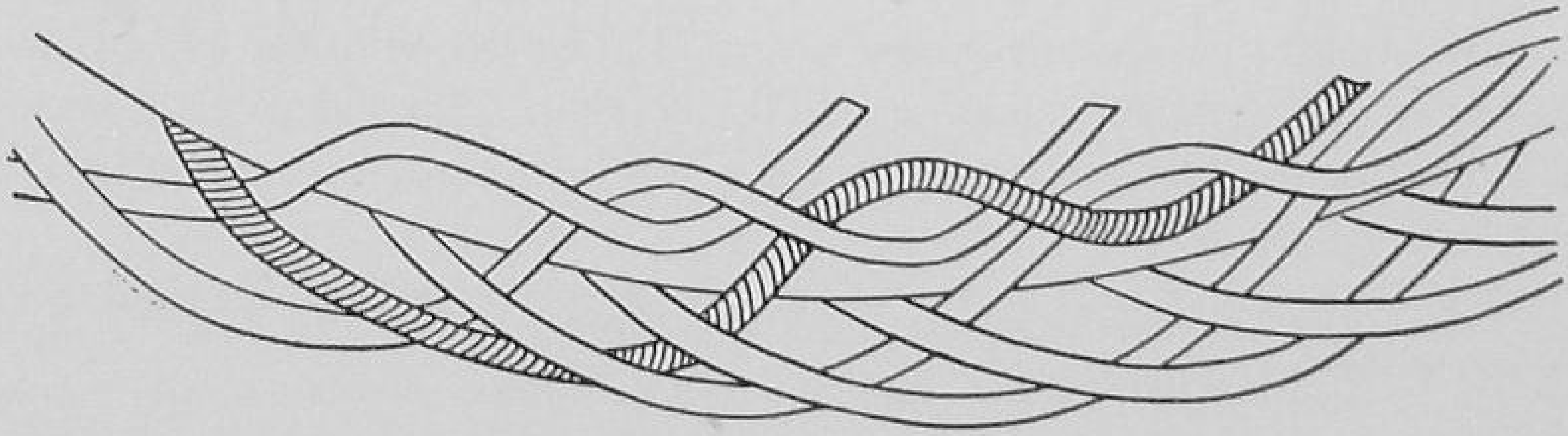


FIG. 37. Closed border VI, rolled edge.

Closed Border VII—Rope Twist

In this border the repetition of one simple stitch forms a closely bound ropelike edge. This edge is especially suitable for fine workbaskets or the edges of basket lids.

First Row. With the basket held right side up, with its edge toward you, carry each spoke, in turn, in back of the next spoke to its right, and to the outside of the basket.

Second Row. Carry each spoke over two spokes to the right, in front of the next spoke to the right, and to the inside of the border, to conceal the spoke ends (Fig. 38).

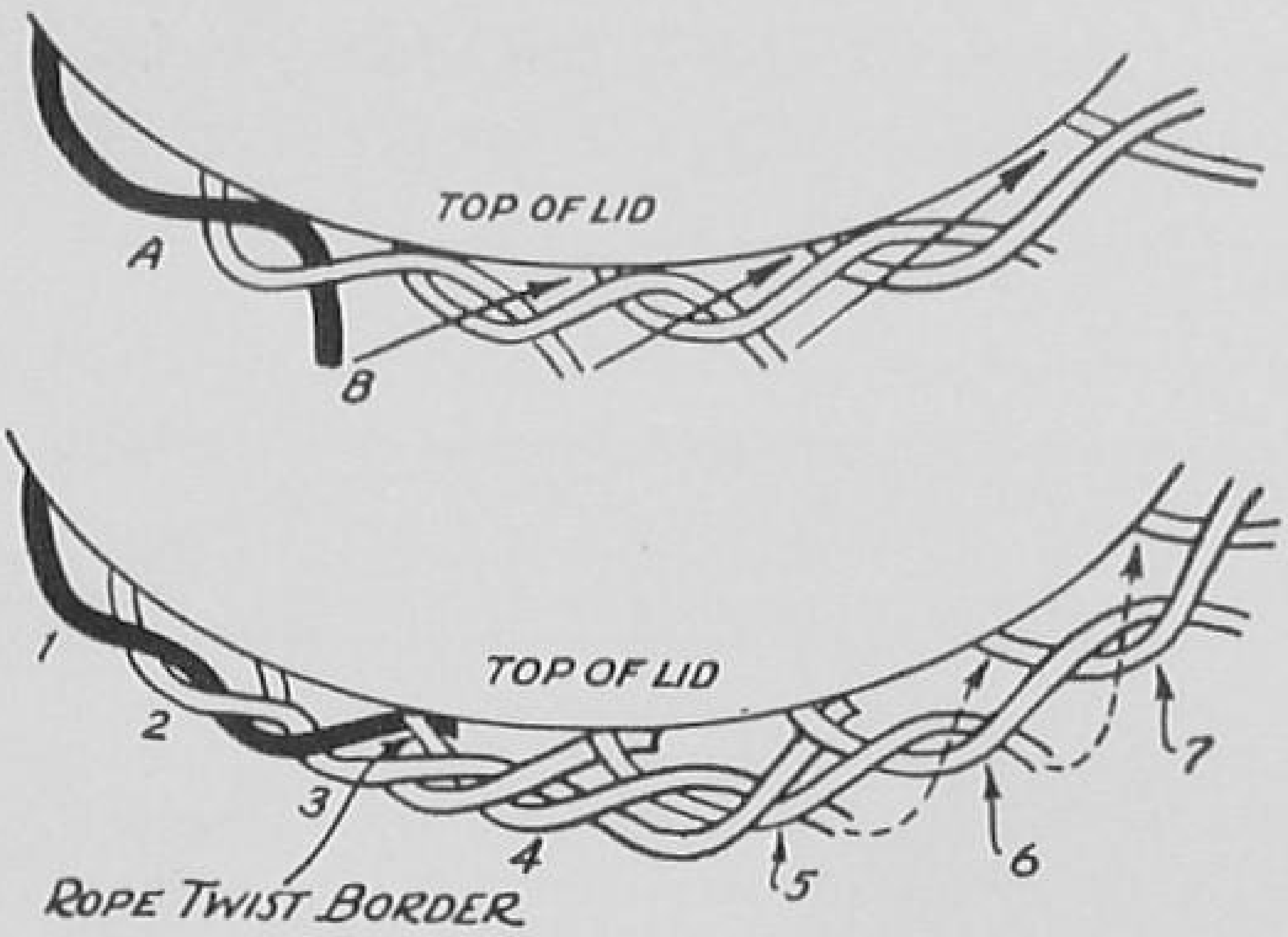


FIG. 38. Closed border, rope twist. Closed border VII.

After all the spoke ends have been concealed, the single twist is added on the inside.

Closed Border VIII—Reverse Rope Twist

This border is very effective on rustic-type baskets. It is a double finishing twist that forms a ropelike edge outside the basket, with the ends of the spokes cut on the slant, showing, on the outside. The end of each spoke is twisted *under* the spoke end to the right instead of *over* it as in the regular single twist.

First Row. Carry each spoke, in turn, behind the spoke to its right, and to the outside.

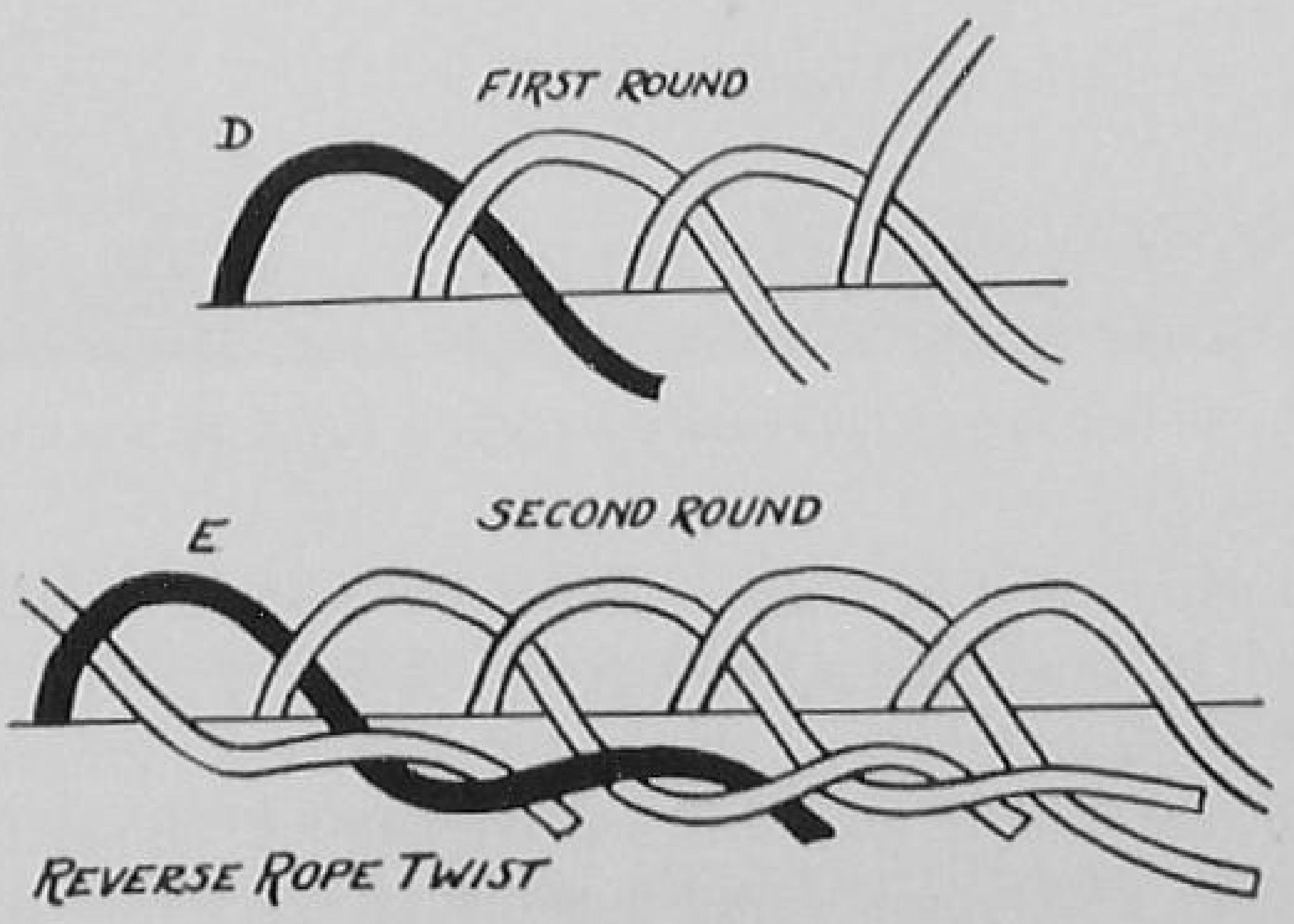


FIG. 39. Closed border VIII.

Second Row. Twist each spoke, in turn, over a spoke end, now to the right, then under it to the outside of the basket (Fig. 39).

Closed Border IX—Wrapped Border

If a very firm, unyielding edge is desired on a workbasket, to act as a support for the edge of a lid, a wrapped border is the solution (Fig. 40).

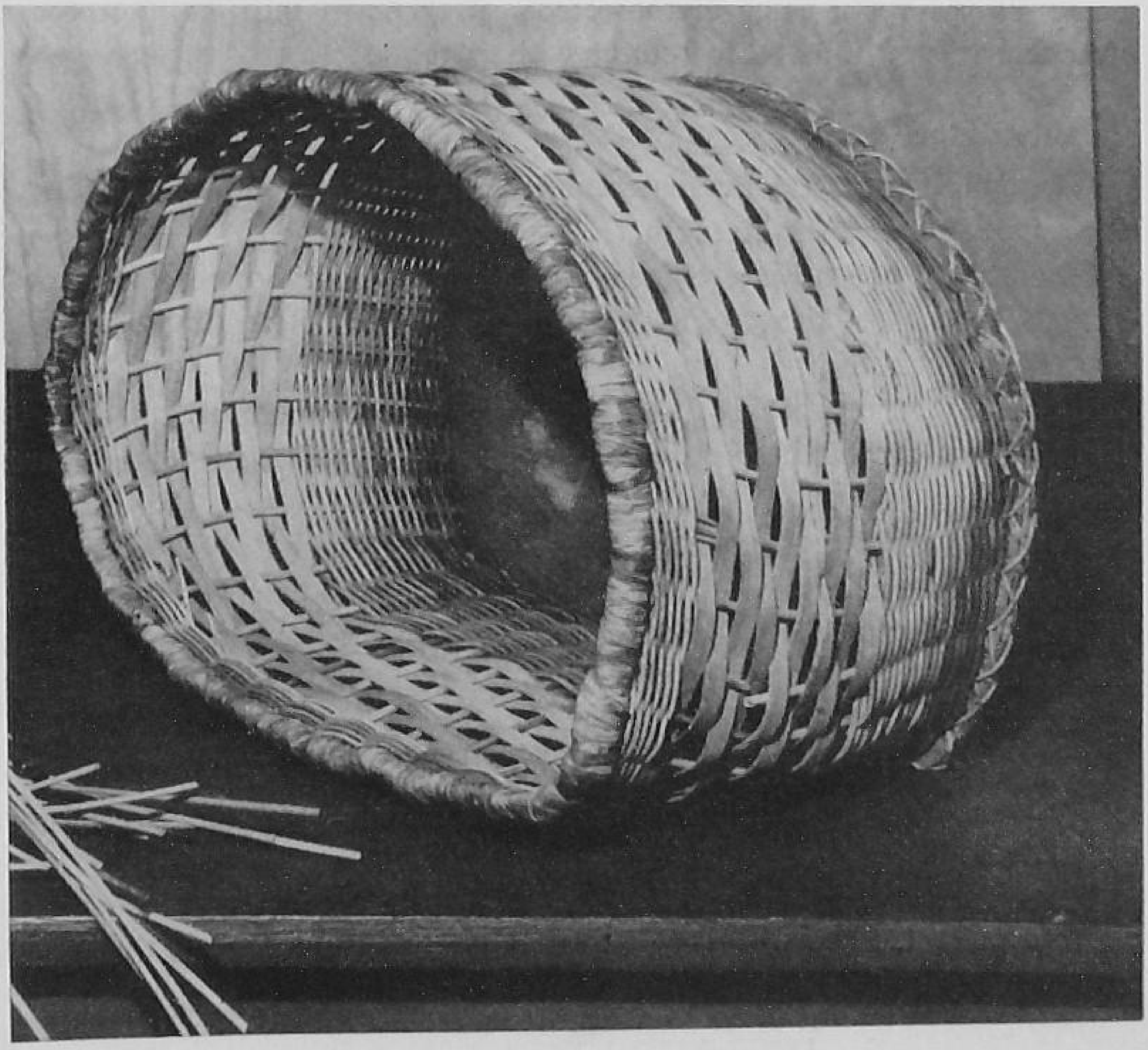


FIG. 40. Raffia wrapped border.

Wrap a single strand of extremely flexible material, such as raffia, or very fine reed, or cane, around and around a heavy foundation rod, such as a No. 6 reed. The length of this rod should be 3″ longer than the circumference of the basket, to allow for overlapping. Loop this heavy rod around the edge of the basket and fasten it in place by catching through several rounds of weavers with the flexible strand at intervals of about 1″.

Continue the wrapping of the heavy rod between the attachment locations until the starting point is reached. Slant both ends of the rod so that when they are overlapped the original diameter is retained. Wrap the joining and fasten it quite securely.

Often this operation produces a narrow ledge or shelf on the inside of the basket. The spokes may be turned down in any of the open border sequences so that the tops of their loops are on a level with the wrapped edge. If the spoke ends are inserted as far down into the weaving as practical they will serve to reinforce the wrapped edge.

Braided Borders

The double incentive for mastering the technique of braided borders is their beauty and their strength.

The spokes are so intertwined that they cannot slip out, as parallel strands cross and recross rhythmically, moving forward in a wavelike procession of curves.

For many strand braids, the original spokes are trimmed off, and the last weavers cut off if necessary, and pushed down against the nearest spoke end.

New weavers of medium-sized reed are soaked, one end dipped in liquid glue and inserted beside each spoke end. To make an even braid, all newly added spoke extensions should be inserted into the weaving on the same side of the spoke ends, and be pushed in far enough to insure their holding.

Braided Border I—Simple Braid Border

Spokes should extend above the finished weaving 5″ if spaces between spokes are under ¾″ and 8″ if spaces measure 1″.

Four rows of weaving are required (Fig. 41).

Step 1. Pass each spoke behind the spoke to its right, and to the outside of the basket (Fig. 41*A*).

Step 2. Roll each spoke under the end of the spoke next to it and let it rest against the second spoke to its right, thus bringing all the spokes to an upright position and still on the outside of the basket (Fig. 41*B*).

Step 3. Pass each spoke over the top of the spoke against which it is resting and carry it behind the next two spokes and out to the outside of the basket (Fig. 41*C*).

Step 4. Carry each spoke along the spoke it is resting against, in front of the two spokes that are now next to it, and in to the inside of the basket (Fig. 41*D*).

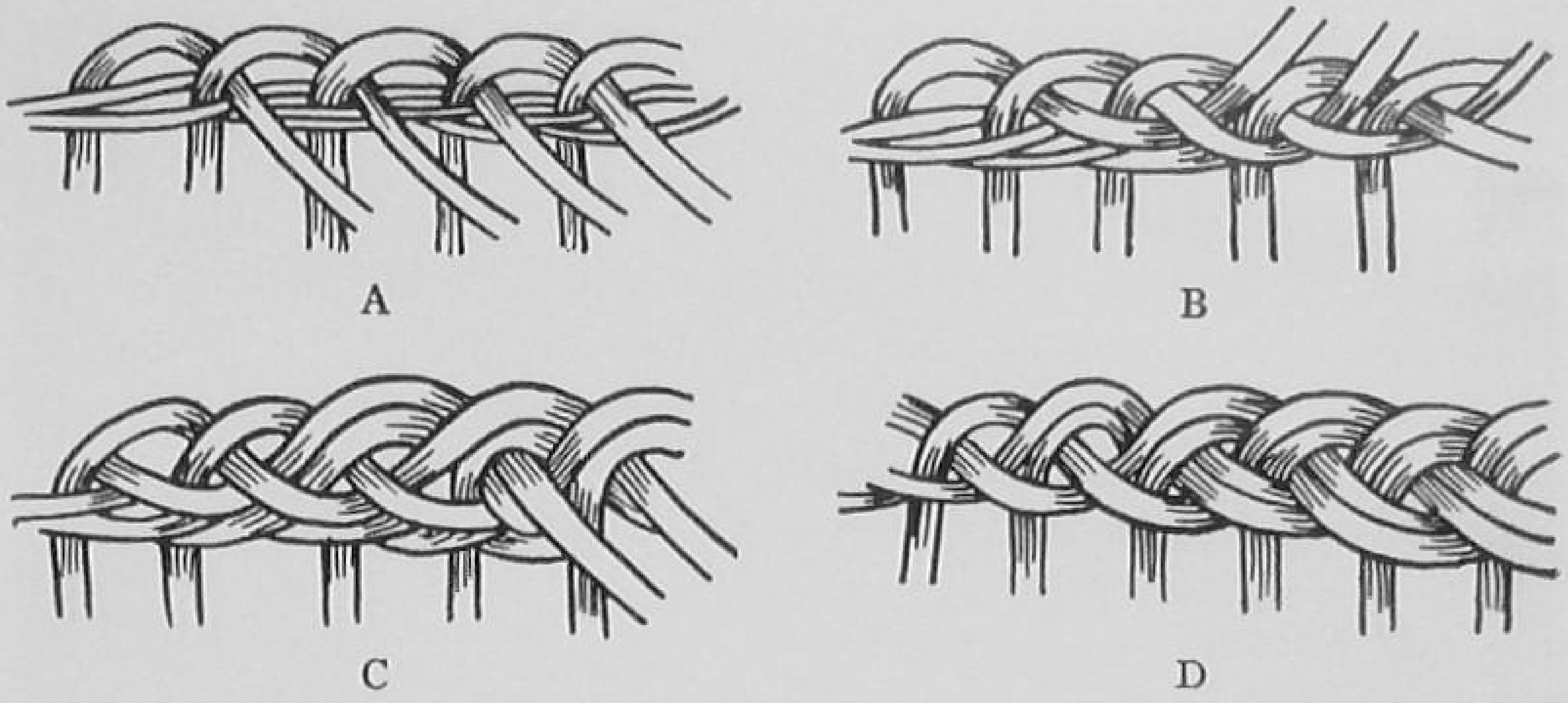


FIG. 41. Simple braid border I.

Braided Border II—Simple Upright Braid Border

This border stands perpendicular to the bottom edge of a basket or tray. Four rows of weaving are required.

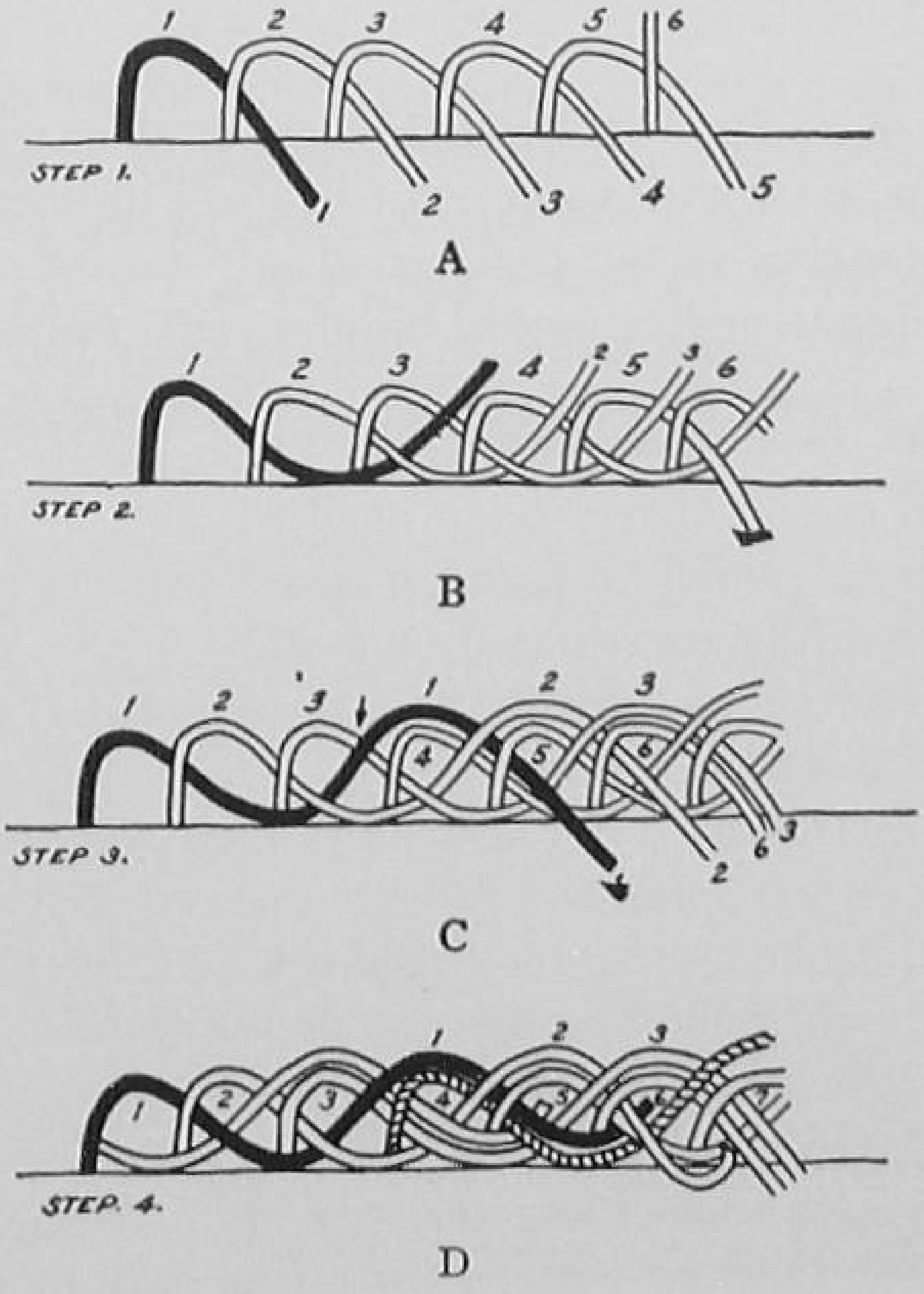


FIG. 42. Simple upright braid border.

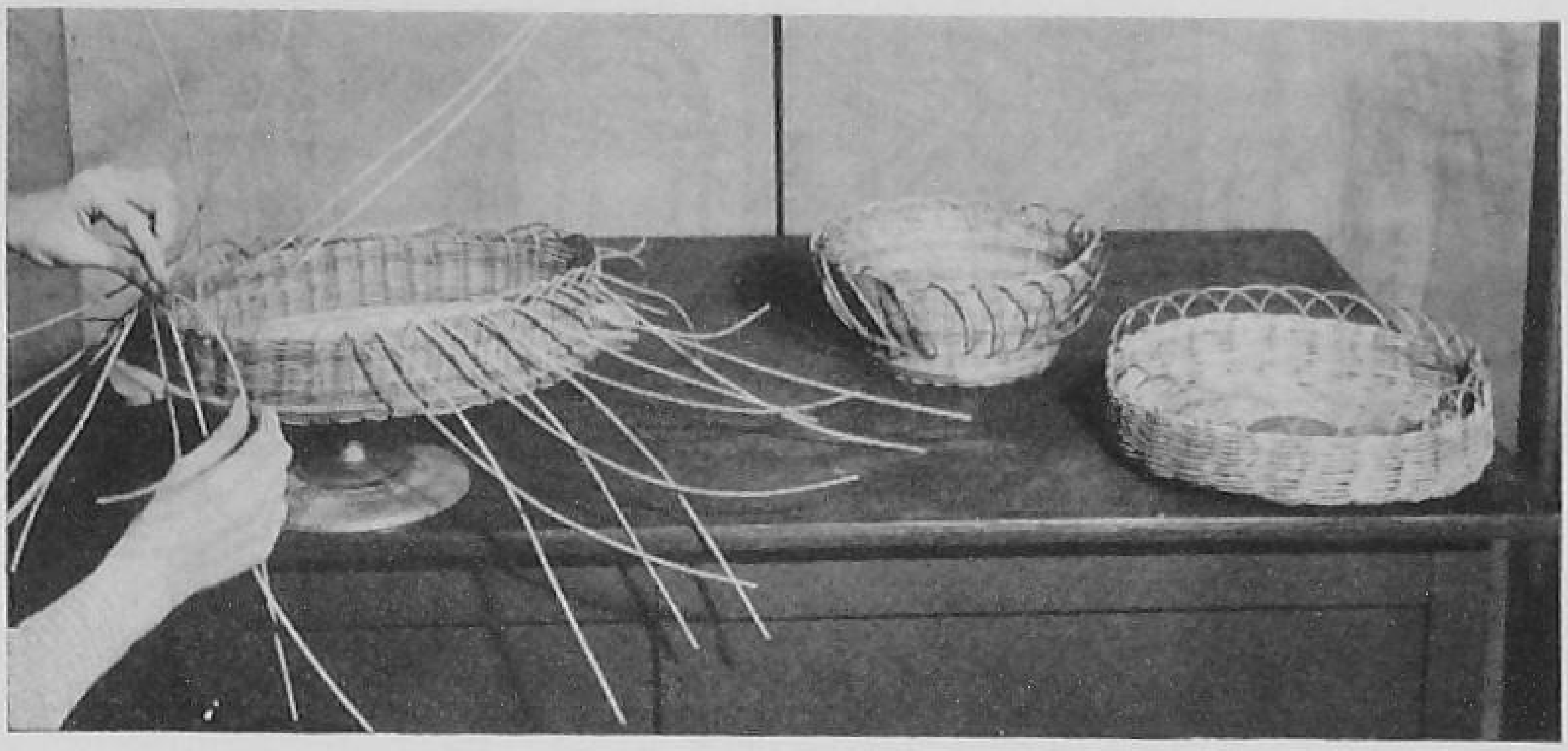


FIG. 43. Upright braid border, step I.

It is an attractive edging for hanging baskets or flower baskets that are viewed from the side.

Step 1. Carry each spoke, in succession, behind the spoke to its right, and to the outside of the basket (Figs. 42 and 43).

Step 2. Carry each spoke end in front of the second spoke to its right, and under the spoke that comes to the outside at this point, then over the curving loop made by the spoke that was just passed over, with the end pointing to the inside of the basket (Fig. 42*B*).

Step 3. Then make a sharp turn in order to carry the spoke parallel to the third spoke to its right in going under the next two ends, and then to

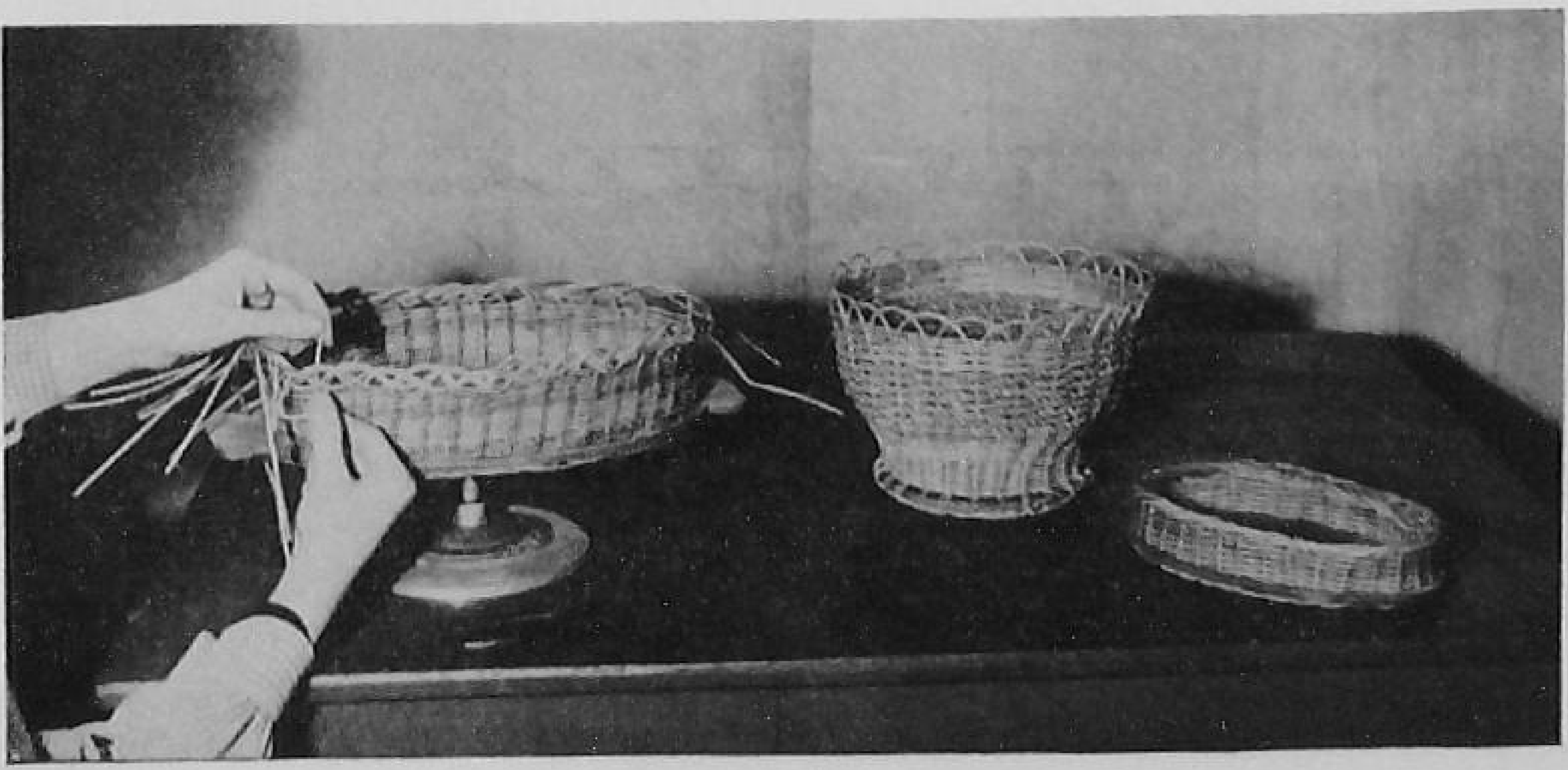


FIG. 44. Upright braid border, step IV.

the outside of the basket. Treat each spoke in succession in like manner (Fig. 42*C*).

Step 4. Carry the spoke end that has just come to the outside of the basket parallel to the same spoke to which it was parallel in step 3, and pass it over the next two spokes, to the inside of the basket (Figs. 42*D* and 44). Treat each successive spoke the same way. Pull all ends taut and trim them on the inside of the basket.

Braided Border III—Rapid Braid Border

This imitation braid border is convenient to use when the spokes are in pairs or close together. It appears much like the simple braid border but is done somewhat more quickly. When the spokes left for a border seem too few, insert other spokes beside them and make a rapid braid border.

Step 1. To weave this border, carry a pair of spokes (or the next two adjacent spokes) in front of the next pair (or the next two) and to the inside of the basket (Fig. 45).

Step 2. Carry spokes 1 and 2 under spokes 3 and 4, over 5 and 6, and to the inside of the basket.

Step 3. Then carry 3 and 4 under 5 and 6, over spokes 7 and 8, and to the inside of the basket.

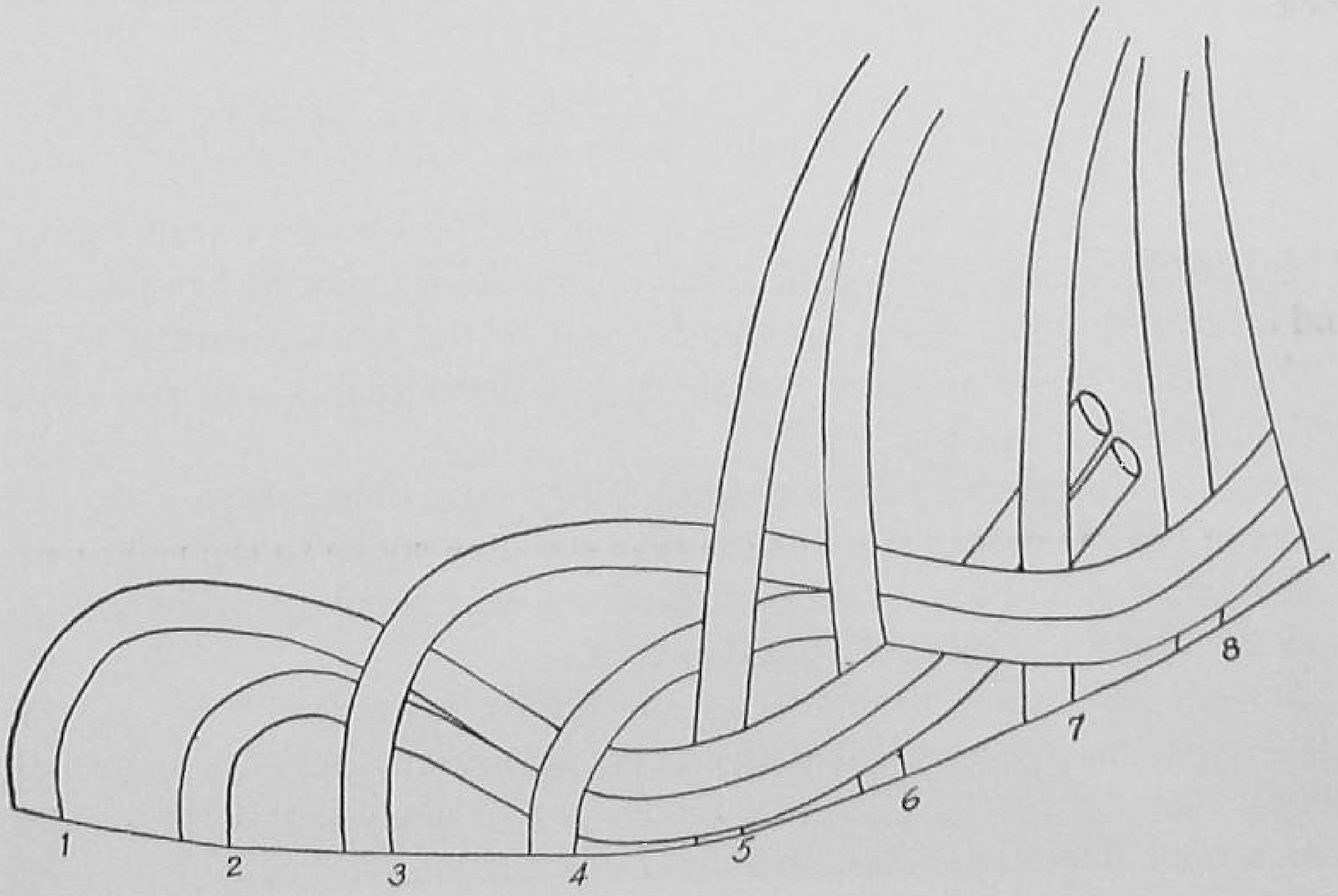


Fig. 45. Rapid braid border.

Treat each successive pair of spokes in a similiar manner around the basket. A sharp fold must be made in the spokes so that the pairs lie parallel in all their interweaving.

The motion is "carry two spokes under two, over two, and in to the inside of the basket."

Braided Border IV—Commercial Border

This border may be made with single spokes or with pairs of spokes used as single spokes. Spokes must be moistened until very pliable as they fold in close folds in completing these steps. If the spokes are numbered to correspond with the numbers in the drawings in Fig. 46 it will be easier for the beginner in basketry to follow the several steps of this border.

Step 1. Start at first spoke, 1 and carry it behind the next spoke to the right, and to the outside. Do the same with spoke 2.

Step 2. Carry spoke 1 in front of standing spoke 3, across laid-down spoke 2, and behind standing spoke 4, to the outside of the basket. Hold the laid-down spokes 1 and 2 with the left hand, and with the right hand bring standing spoke 3 behind spoke 4. Now there are three laid-down spokes (Fig. 46*A*).

Step 3. Carry the single laid-down spoke 2 in front of spoke 4, across 1 and 3, behind 5, and to the outside of the basket. Bring spoke 4 behind 5, to the outside parallel with 2. There are now two double sets of laid-down spokes (Fig. 46*B*).

Step 4. Carry spoke 3 in front of 5, across 2 and 4, behind 6, and to the outside of the basket (Fig. 46*B*).

Carry standing spoke 5 back of 6, and to the outside parallel with 3 (Fig. 46*C*). Bring spoke 4 in front of standing spoke 6, behind 7 and out. Carry standing spoke 6 behind 7 and to the outside parallel with 4 (Fig. 46*C*). There are now two single laid-down spokes and two double sets of laid-down spokes.

Continue in this way around the basket, each time carrying the right spoke of the left pair in front of the first standing spoke to the right across a double set of laid-down spokes, behind the next standing spoke, and out. Lay the first standing spoke parallel to it.

Step 5. When the beginning of the border is reached, and only one standing spoke remains, carry the larger laid-down spoke 24 in front of the last standing spoke 26, across the last set of double spokes, 23 and 25, and behind 1 and out (Fig. 46*D*).

Carry the last standing spoke 26 behind 1, under it, then to the outside,

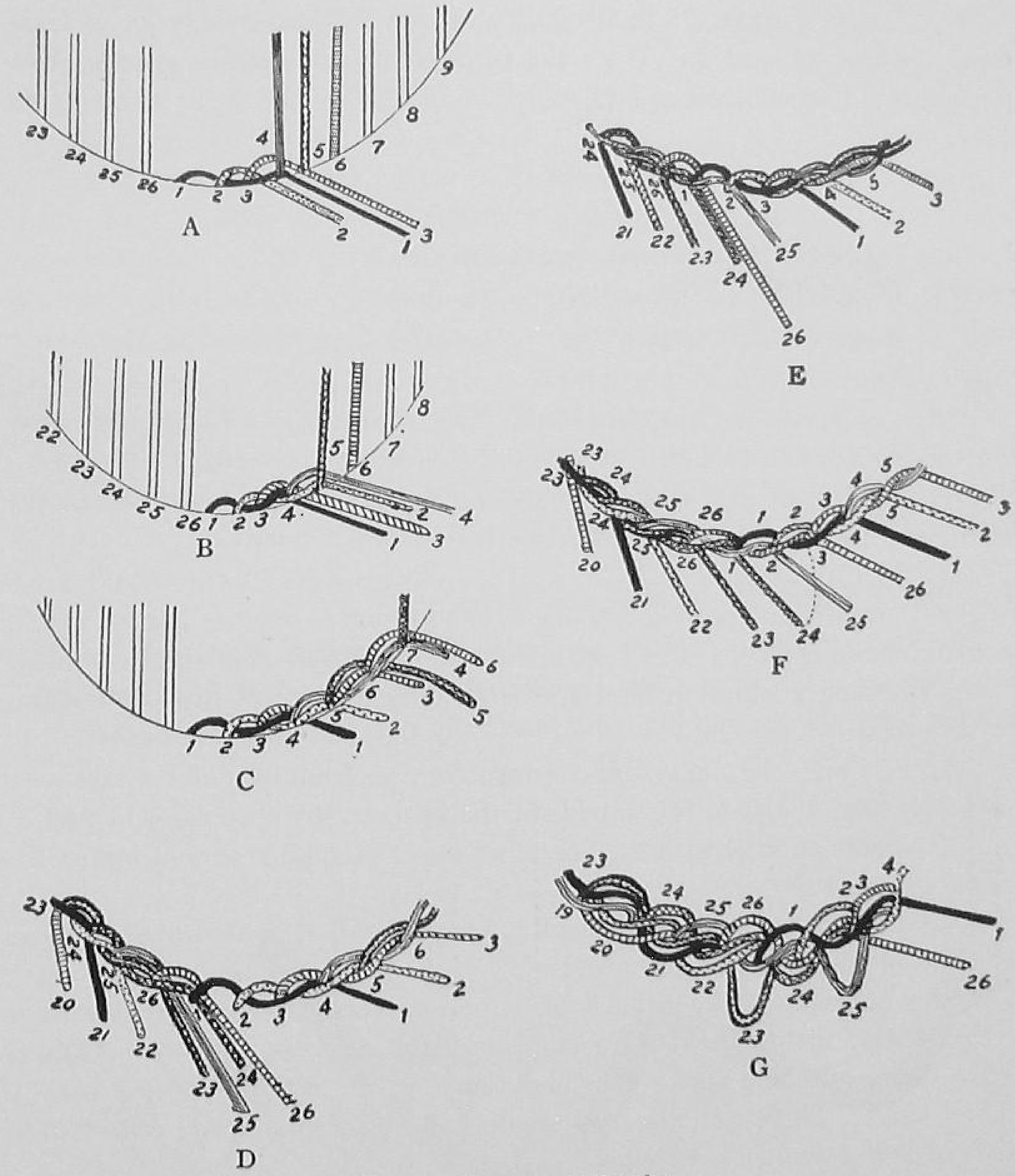


FIG. 46. Commercial border.

parallel to spoke 24. There are now two double sets of spokes on the outside of the basket, 23, and 25, and 24 and 26 (Fig. 46*D*).

Step 6. Carry the right-hand spoke of each set in turn in front of the spoke to the right (which is now a laid-down spoke), and behind the next laid-down spoke, to the outside of the basket (Fig. 46*E*).

Be careful to have these spokes parallel to the already laid-down spokes and not across them.

Step 7. Carry spoke 25 in front of 1, across the last double set of laid-down spokes, 24 and 26. With the scratch awl or another pointed tool push spoke 1 away from 2 and carry 25 *in* and behind 2, to the outside (Fig. 46*F*).

Step 8. Carry spoke 26 in front of 2, across the two spokes 25 and 1, which pass back of spoke 2. With a scratch awl push spoke 2 away from 3 and bring 26 to the outside so that it lies parallel to spoke 1, but does not cross it (Fig. 46*G*). This completes the first row of the border, but to make it more effective and stronger we carry these spokes to the inside of the basket.

Step 9. Bring each spoke in turn in front of one spoke to the right and back of the second spoke to the inside of the basket, making it lie parallel to and in front of the two spokes already passing back of this second spoke. Trim, with a slanting cut, the spokes that are carried inside.

Braided Border V—Flat Braid Border

This is an excellent border for trays, wastebaskets, footstools, or any other woven article that may be viewed from above. It is a horizontal border, lying flat on and extending partially over the top of a basket.

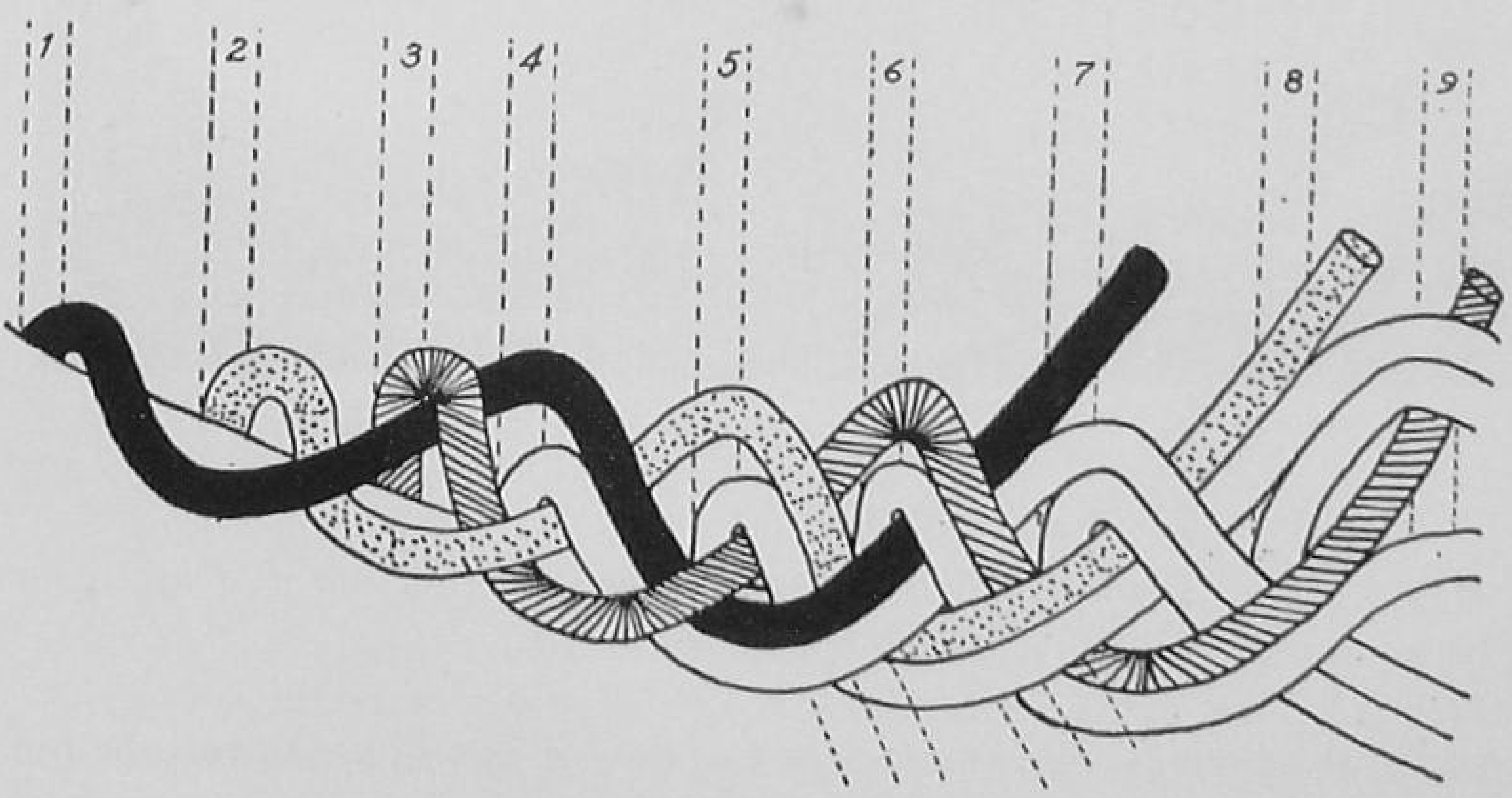


FIG. 47. Flat braid border.

Spokes should extend at least 13″ above the top of the woven basket. They should not be more than ½″ to ¾″ apart. Soak spokes for maximum pliability at the weaving edge. If the spokes are numbered to correspond to those in Fig. 47 it will aid in the weaving sequence.

Step 1. Bend any two adjacent spokes to the outside of the basket Fig. 48).

Step 2. Cross the left one (spoke 1) over the right one (2) and pass it between the next two standing spokes (3 and 4).

Step 3. Then bring down the left one of these standing spokes (3) across spoke 1 (Fig. 47). There are now two spokes (2 and 3) outside and one (1) inside.

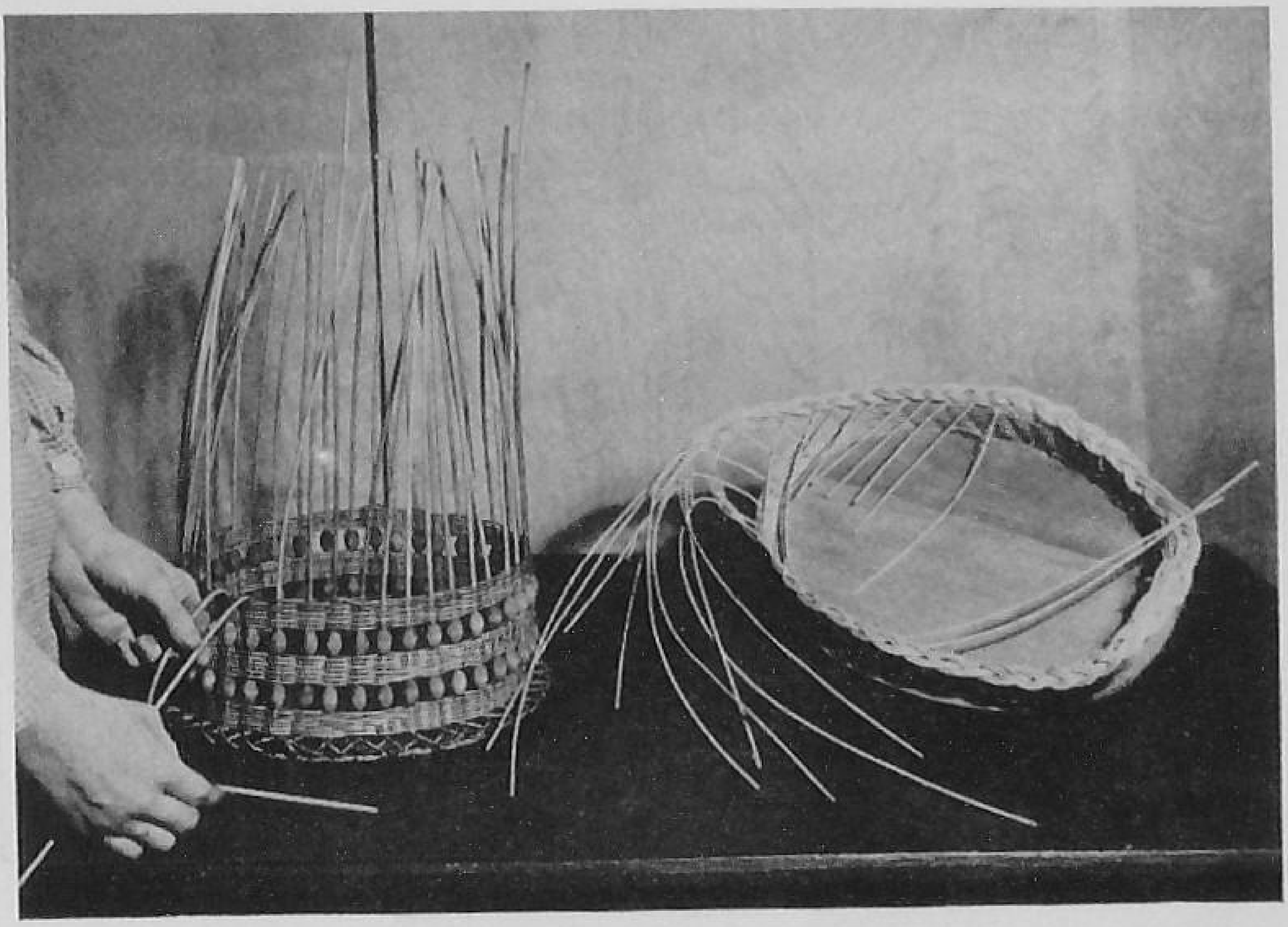


FIG. 48. Flat braid border, step I.

Step 4. Cross the left outside one (2) over the other one (3) and pass it between the next two standing spokes (4 and 5).

Step 5. Then bring down the left one of these standing spokes (4) across spoke 2. There are now two spokes (1 and 2) inside and two (3 and 4) outside.

Step 6. Bring the left inside spoke (1) down next to and parallel to the right outside spoke (4). Spokes 1 and 4 now go to the outside together (Fig. 48).

Step 7. Cross the left outside spoke (3) over these two and pass it between the next two standing spokes (5 and 6).

Step 8. Then bring down the left one of these standing spokes (5) across spoke 3.

Step 9. Bring the left inside spoke (2) down next to and parallel to the spoke just brought down (Fig. 49). Spokes 2 and 5 now travel to the outside together. There are now two pairs of spokes outside (1 and 4, and 2 and 5) and a single spoke inside (3) (Fig. 49).

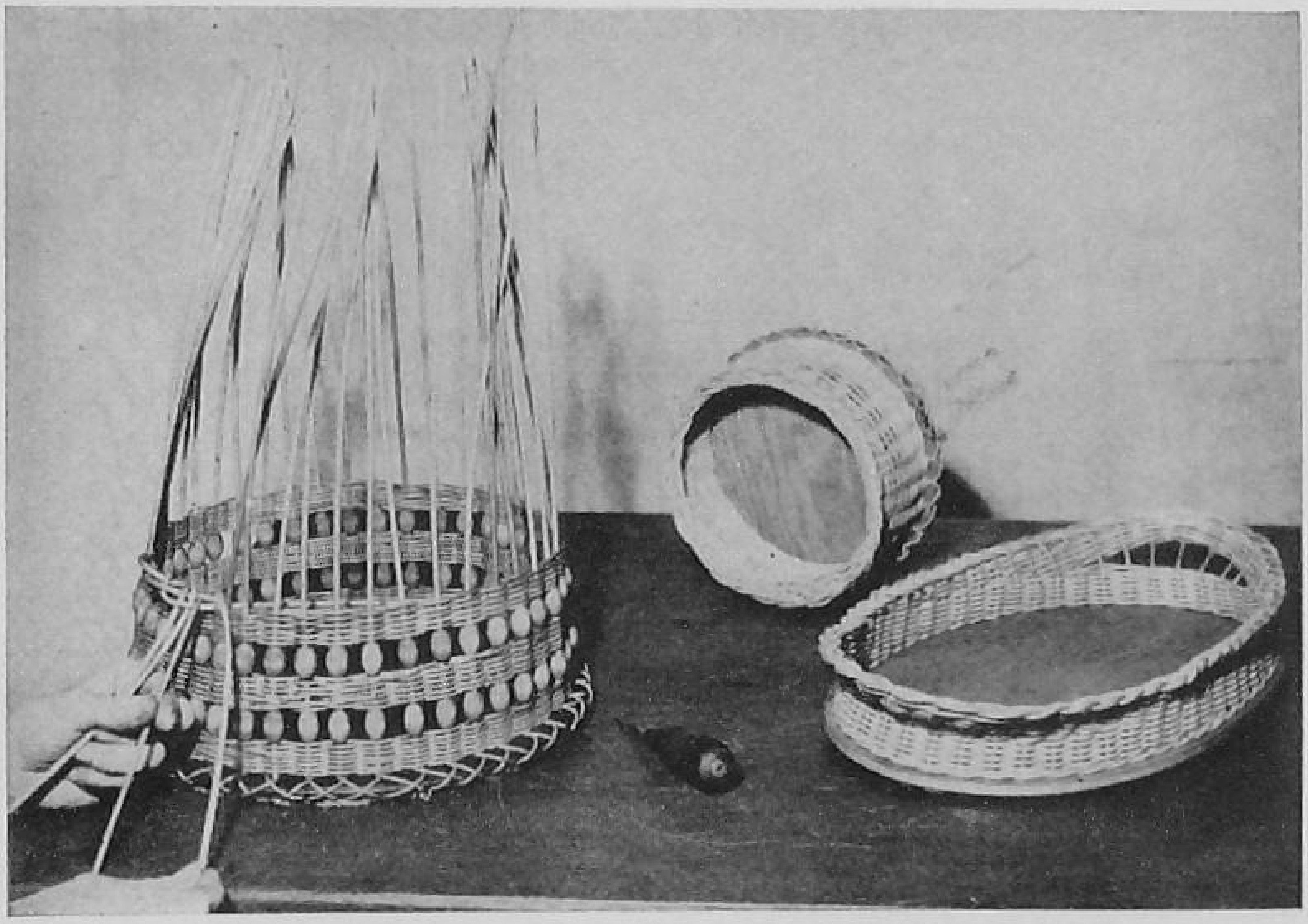


FIG. 49. Flat braid border, step III.

Step 10. Cross the left outside pair (1 and 4) over the other pair (2 and 5) and pass them between the next two standing spokes (6 and 7) (Fig. 50).

Step 11. Bend down the left one of these standing spokes (6) across spokes 1 and 4 and bring down the inside spoke (3) to the outside, parallel to spoke 6. Spokes 3 and 6 now travel to the outside together.

There are now two pairs of spokes outside (2 and 5, and 3 and 6) and one pair (1 and 4) inside, as shown in Fig. 51.

Step 12. Cross the left outside pair (2 and 5) over the right outside pair (3 and 6), pass the former between the next two standing spokes (7 and 8).

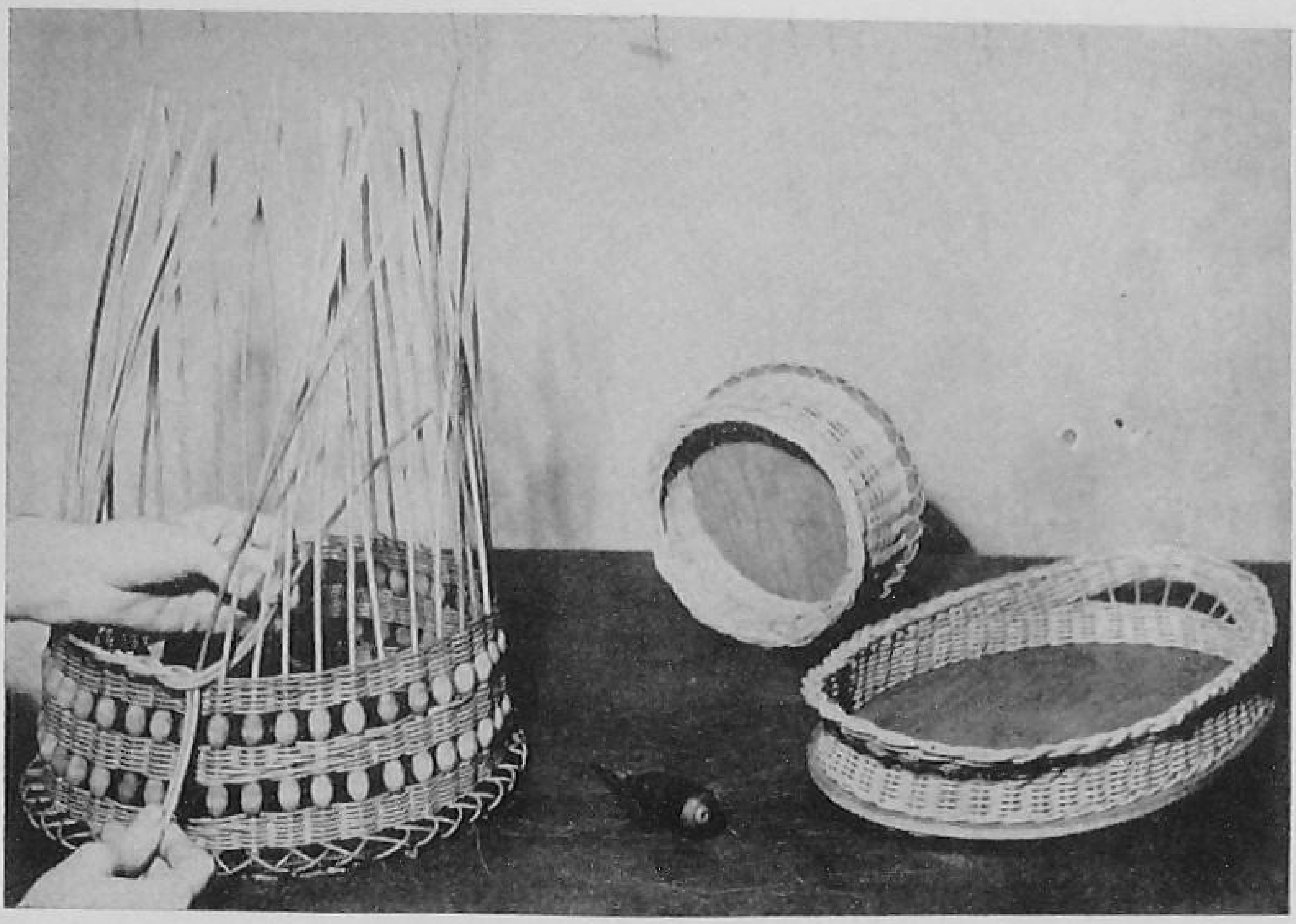


FIG. 50. Flat braid border, step IV.

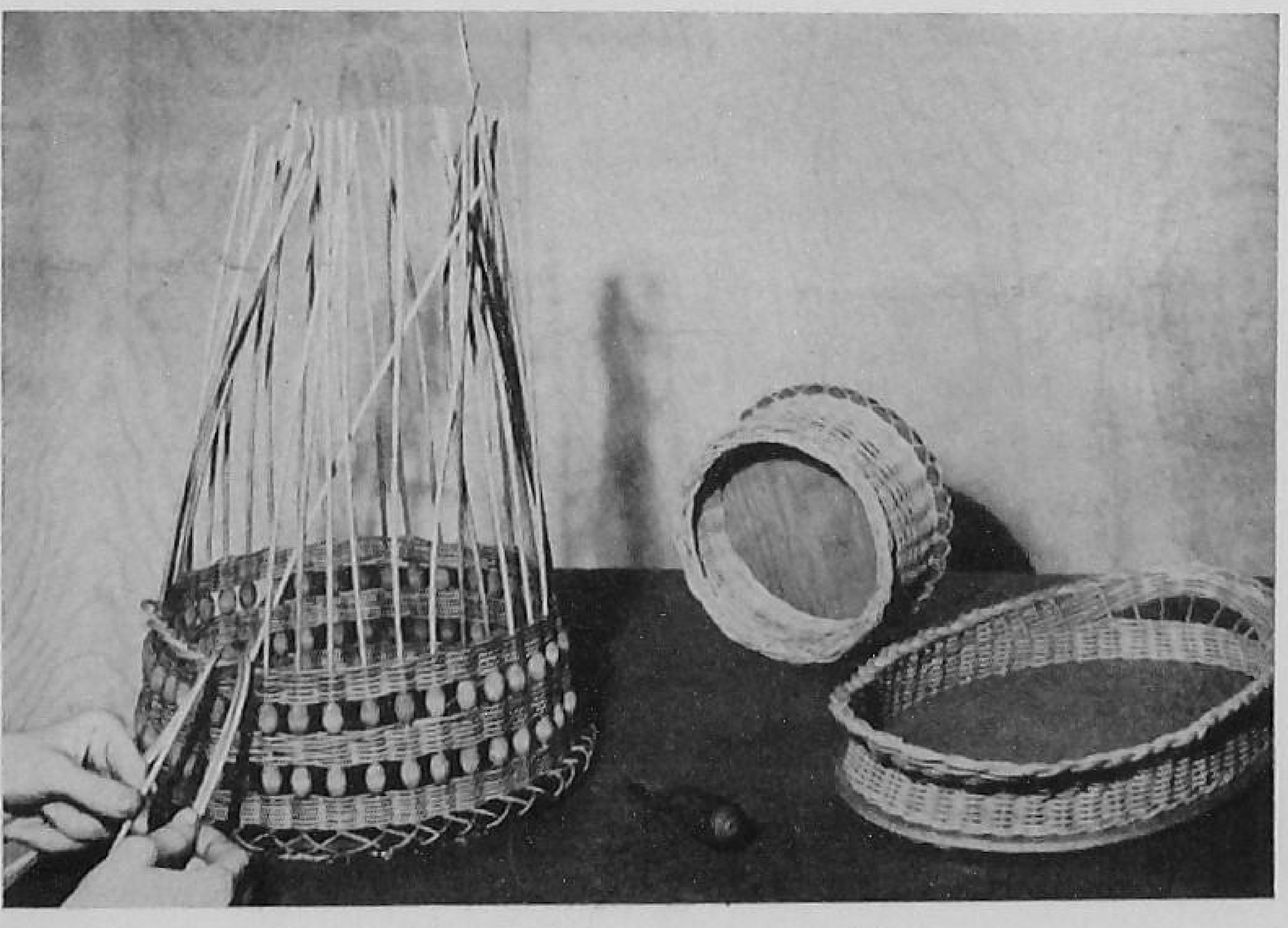


FIG. 51. Flat braid border, step V.

FIG. 52. Flat braid border, step VI.

Step 13. Bend the left one of these spokes (7) down over the other pair. There are now two pairs of spokes on the inside of the basket (1 and 4, and 2 and 5).

Step 14. Drop the short spoke (1) of the left pair and lay the long remaining spoke (4) parallel to the standing spoke (7) just brought down. There are now two pairs (3 and 6, and 4 and 7) outside and one pair inside (2 and 5).

Step 15. Continue crossing the left outside pair over the right outside pair and passing them between the next two standing spokes; and bend the left one of these standing spokes down over the remaining outside pair.

FIG. 53. Flat braid border, step VII.

Drop the short spoke of the inside pair and lay the remaining spoke parallel to the standing spoke just brought down to the outside (Fig. 52).

Repeat this sequence until all standing spokes have been bent down. When the starting spoke is reached all remaining spoke ends must be paired with beginning spokes. They follow the paths of the starting spokes, being carried parallel to single ones already woven (Figs. 53 and 54).

Fig. 54. Flat braid border, step VIII.

Braided Border VI—Wider Braided Border

This is a continuation of the flat braided border with each spoke braided along a little farther, making three parallel spokes on the inside of the braid (Fig. 55). This makes a little wider braided border that is very effective on large trays, reed tables, chairs, and large baskets.

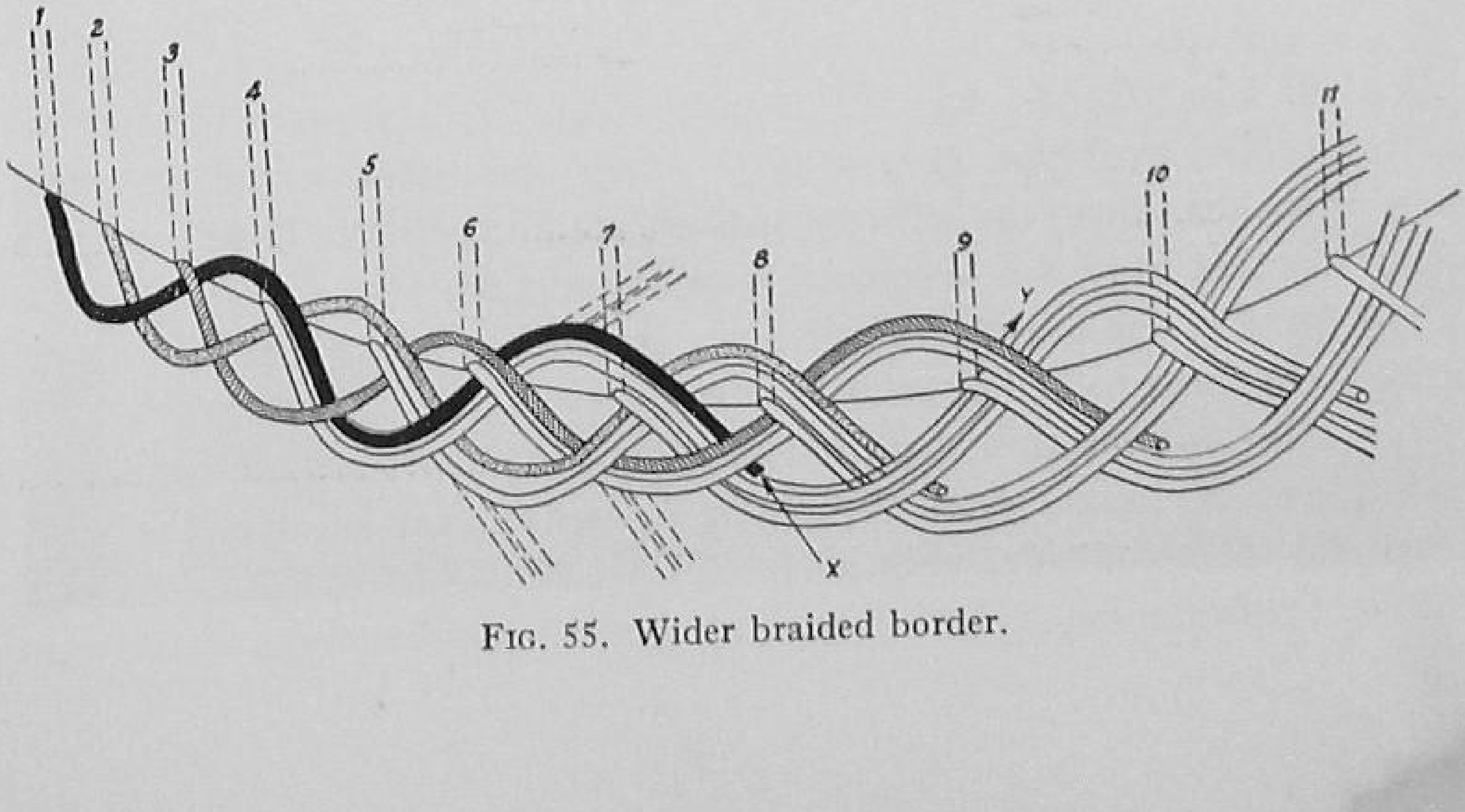


Fig. 55. Wider braided border.

Steps 1-12. Follow instructions for *Steps 1-12* for flat braid border (pages 53 and 54).

Step 13. Bend down the left spoke (7) over pair 3 and 6 and also lay pair 1 and 4 down parallel with 7, carrying all three (7, 1, and 4) to the outside of the basket.

As each standing spoke is brought down, lay the left inside pair parallel to it. In this way the three go to the outside as one instead of the short spoke of the inside pair being dropped, as is done in the flat braid border. When there are two groups of three spokes each on the outside and a pair of spokes on the inside, repeat the following sequence around the basket. Let the shortest spoke of the left outside group remain on the inside of the set of three spokes (see *X* on Fig. 55) and carry these three to the inside between the next two standing spokes.

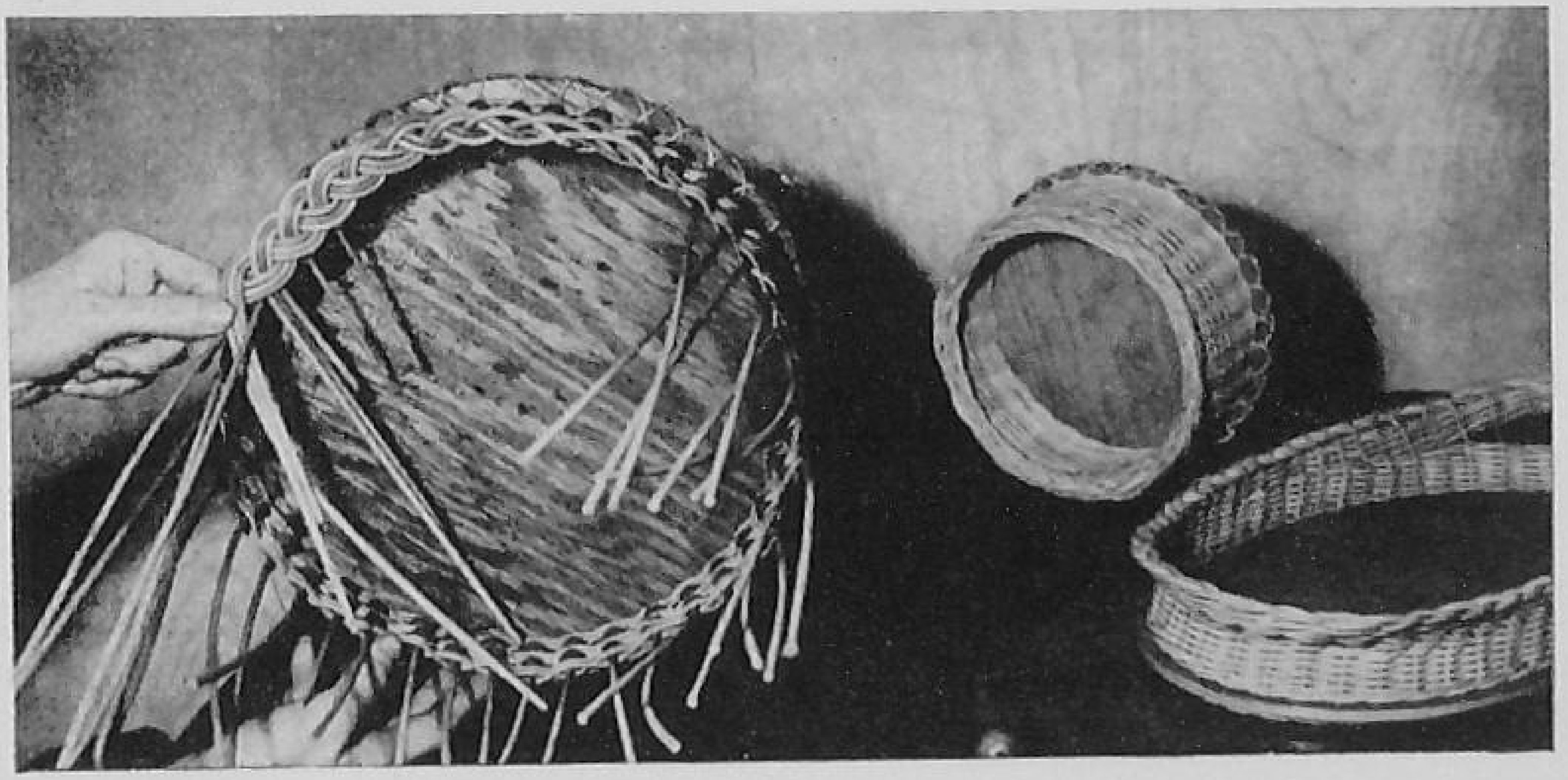


FIG. 56. Wider plaited border, top view.

Step 14. Discard the extreme left spoke (Fig. 56) and carry the two remaining spokes over the other outside group and between the next two standing spokes. Bend the left one of these standing spokes down over the two spokes that have just been carried to the outside.

Step 15. Lay the left inside pair down parallel to spoke just laid down. Carry these three to the outside as one.

Step 16. Continue this operation of letting the short strand remain on the inside of the basket while the remaining two are carried over the other group and to the outside. (Fig. 56).

When the beginning spoke has been reached all the remaining spoke ends

must be adjusted beside the spokes they would naturally follow. It is advisable to soak the spoke ends before attempting the final adjusting of the spoke ends in the braid. The outside ends of the spokes are trimmed on a slant.

If a still wider braid is desired, all three spokes on the outside may be carried over the other outside group and to the inside of the basket. This will give three strands parallel on both the inside and the outside edge of the braid. See Fig. 56, which shows the top view of the wider plaited border.

Chapter VI

PROJECTS IN REED BASKET MAKING

Wastebasket

(round or oval wooden base with spokes inserted through base)

Materials

- Plywood for base
- No. 4 reed spokes (uneven number of holes)
- No. 0 reed for overedge
- No. 2 reed for weavers
- Hong Kong grass (8 times diameter of basket for each strand of pairing weave) used in round basket shown in Fig. 57

FIG. 57. Round and oval waste baskets; Cover for sewing basket.

Tools

- Reed cutters
- Awl
- Pans for soaking reed
- Rasp
- Hand drill
- Coping saw

Procedure

The base of this basket may be almost any shape, but round or oval baskets are most easily woven. The base may be made from soft wood or plywood, at least ¼″ thick.

Step 1. Saw out the base and smooth it with a rasp or sandpaper. Drill an odd number of ⅛″ holes ⅜″ from the edge.

Step 2. Cut the spokes the desired heighth of the basket plus 2″ extra for the base border and 14 to 16″ additional for the flat braided border. Insert these with a twisting motion through the holes in the base allowing about 2″ to protrude.

Step 3. Soak length of No. 0 reed and use it in the overedge-loop weave. (See page 14 and Figs. 6*A* and *B*).

Step 4. Turn the spoke ends under for a base border according to instructions on page 15.

Step 5. Begin the actual weaving. Use the No. 2 reed in the simple pairing weave, for about 3″ to form a firm close foundation for any combination of other weaving sequences.

Step 6. On the model shown in Fig. 57 No. 2 reed was continued in the simple over-and-under weave until just before the contrasting band of Hong Kong grass was added near the top.

Step 7. A single round of simple pairing was woven before the ten rounds of Hong Kong grass which were done in simple over-and-under weave.

Step 8. Another round of simple pairing was added after the ten rounds of the grass to insure a firm top edge.

Step 9. A flat braided border was used to finish the wastebasket (see directions in page 52 and Figs. 47 through 54).

Step 10. When the basket was thoroughly dry a coating of white shellac was brushed over the base, reed, and Hong Kong grass to insure against absorption of moisture.

Sewing Basket With Cover (Fig. 48)
(7″ high and 12″ in diameter, with wooden beads)

Materials

Plywood for base: 12″ square, 3-ply birch, ¼″ thick
No. 4 reed spokes, uneven number, 24″ long; 33 used in basket in Fig. 48
No. 0 round reed for overedge loops, 2 lengths
No. 2 round reed for weavers, about ¼ lb. for 7 to 8″ basket and lid

1″ wooden beads—twice the number of the spokes, with holes at least ⅛″ diameter, to slide over No. 4 reed. Beads may be natural wood, or painted or dyed
Wood stain, shellac
1½ yds. lining material, at least 36″ wide

Tools

Reed cutters	Coping saw	Sand paper
Awl	Rasp	Hand drill

Procedure

Step 1. Mark the plywood square in a 12″ circle and remove the corners by sawing with a coping saw. The roughness of the edge is removed with a rasp or coarse sandpaper before the locations of the spoke holes are indicated.

Step 2. Either 31 or 33 spokes, depending on the distance from the basket edge, are sufficient for a 12″ diameter basket. A greater number reduces the space between any two spokes, and too narrow spaces may cause difficulty in folding the border as flat as is necessary to insure a closely fitting lid. Mark these holes for the spokes ½ to ¾″ from the edge and at least 1″ apart.

Step 3. In the base drill ⅛″ holes with the hand drill and smooth the surfaces with fine sandpaper. Cut one end of each spoke on a slant and insert with a twisting motion through the holes in the base allowing about 2″ to protrude (Fig. 7). Spokes measuring 24″ in length are needed for a sewing basket 6 to 8″ high, as 2″ is needed in turning the base border, with an additional 14″ for the flat plaited border.

Step 4. Use length of soaked No. 0 round reed in the overedge-loop weave (see page 14 and Fig. 6*A*).

Step 5. After soaking the spoke ends, turn them under as a foot border, as shown in Figs. 10, 15, 16, 17.

Step 6. Use No. 2 reed in simple over-and-under weave for 12 or 13 rounds of the basket with the reed end inserted down beside the nearest upright spoke, according to instructions for hidden piecing, page 17.

Step 7. Place a wooden bead over each upright spoke and press it down over the round of simple weaving.

Step 8. Weave another 12 or 13 rounds of simple over-and-under weave and insert the reed as before.

Step 9. Place the second row of beads on the uprights and press them into place.

Step 10. Make a third series of simple over-and-under weaving to produce a firm framework on which to fold the flat plaited border.

Step 11. Make a flat plaited border (see page 52, Figs. 47 to 54).

Step 12. Finish as desired.

Basket Cover (Fig. 57)

Step 1. Cut 10 spokes of No. 2 reed, each 14″ long, and 1 spoke of No. 2 reed, 7″ long. Find the center of five of the longer spokes and with an awl or knife make a small slit in each, as in Figs. 81*A* and *B*, long enough to run the remaining five spokes through, having all the ends even.

Step 2. Place the 7″ spoke in the center of the longer ones, as in Fig. 82*A*, with one end just through the slit spokes, thus forming a half spoke. This gives the uneven number of spokes required for under-and-over weave.

Step 3. When the eleven spokes are in place, cut a strand of No. 0 reed in half to make two weavers. Insert the ends of the two weavers in the split spokes, one on each side of the group of six already passing through the split ones (Fig. 82*B*).

Step 4. Cross the weavers over the center of the spokes and carry them to the back and cross. The weavers are now in the same position as they were at the start (Figs. 83 and 84).

Step 5. Cross the left or weaver 1 over the group of six spokes, over weaver 2 and behind the next group of five spokes.

Step 6. Do the same with weaver 2. Repeat this, pairing the group of spokes once more with weavers 1 and 2.

Step 7. Take each spoke separately and pair with the same weavers for five rows to make a firm, rigid center. Cut the end of the weavers and insert along successive spokes toward the center of the basket as in hidden piecing (Fig. 12).

Step 8. Change to No. 1 reed and continue simple pairing until the basket cover is 4″ in diameter.

Step 9. Cut additional spokes on a slant on one end and insert one spoke beside each original spoke and push it toward the center.

Step 10. After four or five additional rows of simple pairing, separate the original and additional spokes and continue the simple pairing. It will be noted that after the separation of the original and additional spokes there are twice the number of spokes radiating from the center of the

basket cover as there were at the beginning. These add to the beauty and strength of the woven cover.

Step 11. When the basket cover measures about 11″ in diameter, or is large enough to rest on the flat basket border, cut the weavers and tuck them in and down beside two successive spokes.

Step 12. Make the border by looping each spoke in front of one spoke and behind the next; then insert it down beside the third spoke for at least 1½″. Cut the ends of the spokes on a slant before inserting them and use the awl for enlarging the spaces in the woven section. The curve of the looped spokes must be uniformly regulated to the desired height, so that the edge does not extend beyond the flat plaited border of the basket.

Reed Loop and Ring on Cover

A ring of reed for a handle on the cover may be formed of a short strand of No. 1 reed. A loop to hold this ring to the basket top must be attached at the center of the cover.

Make this loop by inserting a small piece of No. 1 reed under the five split spokes with the ends extending on each side of the group. Twist the ends around each other and draw them through to the underside of the cover, where they are cut on a slant and inserted in the weaving.

Pass one end of a short strand of No. 1 reed through this loop on the outside of the cover and form a ring 1″ in diameter by twisting the long end over and under until it passes the first end three times. Cut on a slant the ends of the reed forming the ring so that a smooth surface results. Also trim on a slant any short ends on the inside of the basket cover, whether a lining is to be attached to the cover or not.

Finishing

After the basket and cover are thoroughly dry, stain or shellac the inside and the outside of both basket and cover, allowing sufficient time for a thorough drying, before lining with printed cretonne, chintz, or silk.

Lining the Basket

Cut a cardboard disc to fit the bottom of the basket, and cover one side with a layer of cotton batting. Follow the diagram for cutting the lining (Fig. 58). Using the cardboard disc as a pattern, cut two pieces of lining material, allowing ½″ of the material to extend beyond the edge of the cardboard. Place the cardboard, cotton side up, on one layer of the lining material and fold the ½″ extra material smoothly over the edge. Hold

this fold in place by stitching the cut edge to the cotton batting. Place the other piece of the lining over the cotton-covered side and turn under the extending edge to the inside of the lining. Pin the entire circumference, placing the pins at right angles to the edge so that they need not be removed until after the edges of the two pieces of lining have been overhanded together. The two ends of a strip of material—at least one and a half times the circumference of the padded disc, and at least 1″ wider than the depth of the basket—are joined together forming a loop. For

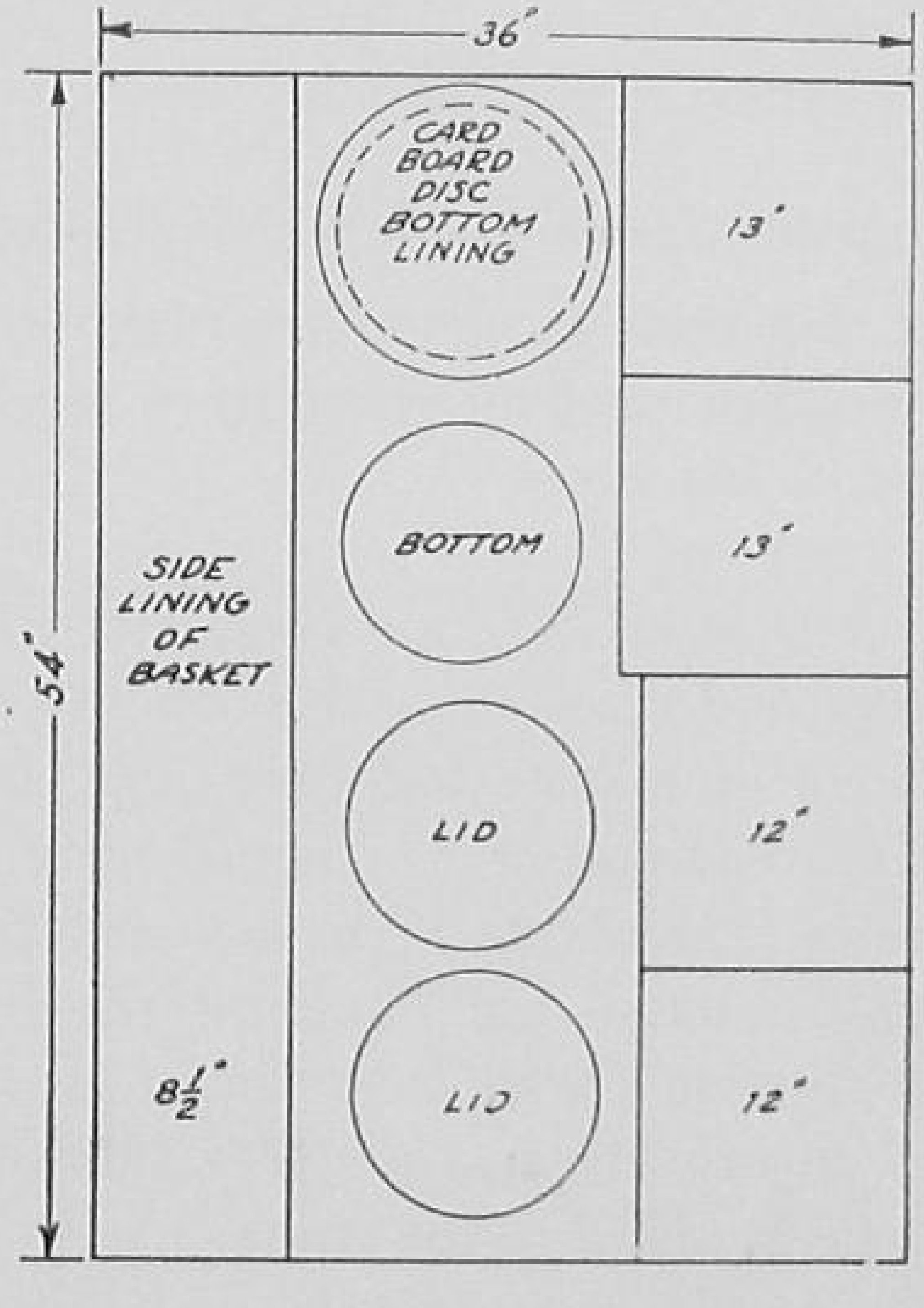


Fig. 58. Diagram for cutting the lining.

the sewing basket shown in Fig. 58 the strip of lining for the basket side measured 1½ yds., or 54″ by 8½″ wide. Side pockets for sewing accessories, loops for scissors and thimble, as well as a pincushion may be attached to this side lining. One edge of this loop is gathered by running a heavy thread ½″ from the edge. This thread is then pulled to adjust the side lining evenly to the size of the bottom disc. Then it is stitched in place by whipping the gathered edge of the side lining to the edge of the disc. Fit the lining into the basket and fasten it in several places by stitches around the spokes near the basket base. Gather the other edge of the lining and fold it back just under the flat plaited border. Take the

stitches that hold the lining at the top around the spokes so that they are less noticeable than if made over the weavers.

Lining of Cover

If a lining on the basket cover is desired, a second cardboard disc may be covered, following the directions for the basket bottom. Two layers of material, without the padded cardboard between, but with the edges overhanded together may be fastened to the edge of the cover with stitches going over the spokes. This will insure sufficient foundation for tapes to hold scissors or spools of thread.

Reed Serving-Tray with Self Handles

It is very apparent that the most popular article in basketry is a well-made serving tray. Wooden bases for these trays come in various shapes

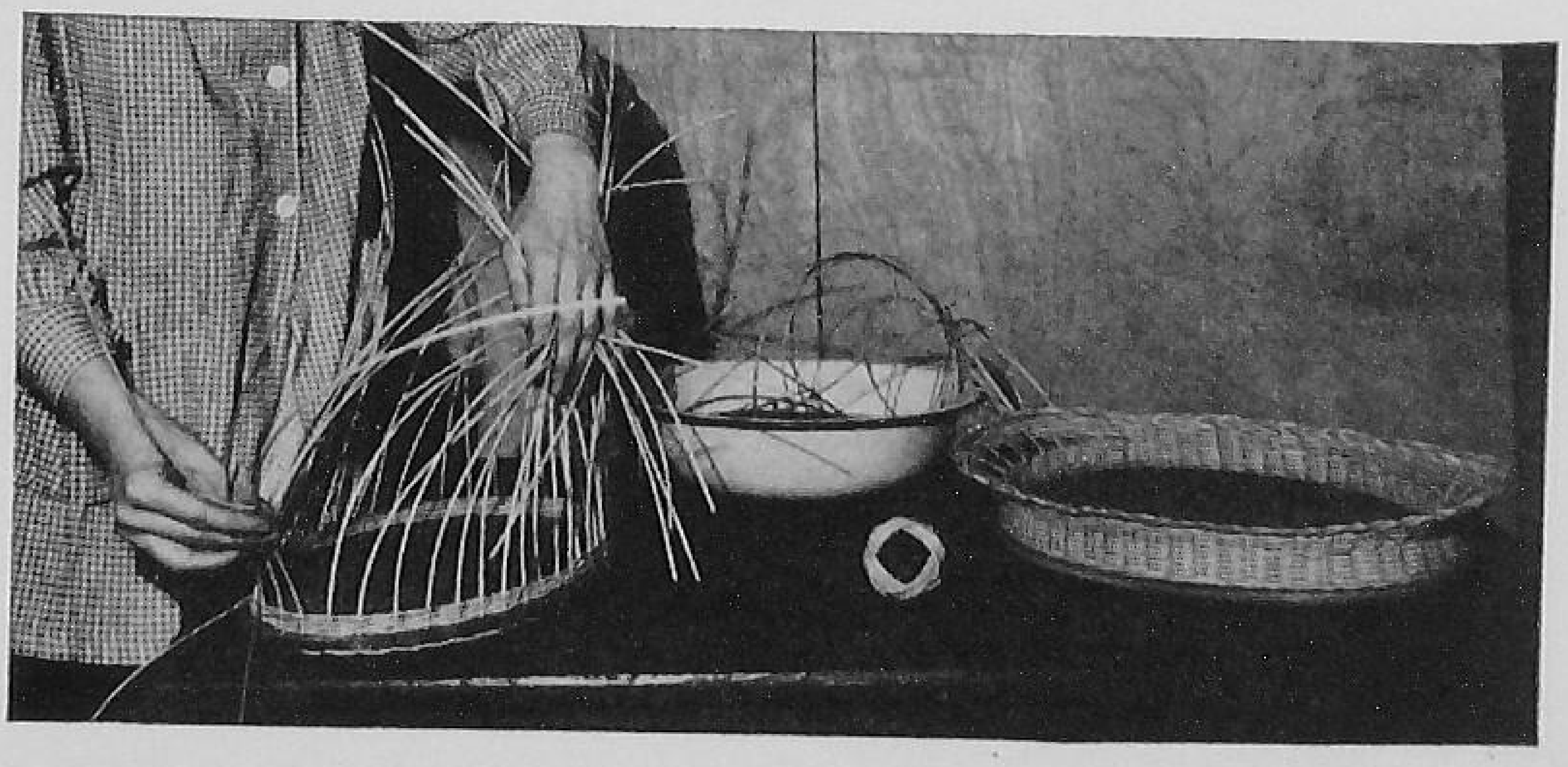


FIG. 59. Shaping end spokes for handle.

and sizes—bored for No. 3 and No. 4 spokes. Or the bases can be made from ¼″ 3-ply birch. The most practical sizes for wooden tray bases are 12″ x 18″ for a rectangle, 12″ x 19″ for an oval tray, and 12″ in diameter for a round one.

The tray base shown in Fig. 59 is a 12″ x 19″ oval containing 45 spokes. The spokes are cut 20″ in length to insure the necessary 2″ for the base border as well as the additional 14″ needed for the flat plaited border.

Tools

Coping saw
Hand drill with drill for No. 4 reed
Rule
Pencil
Scissors
Diagonal cutters or end-cutting pliers

Materials

12″ x 19″ plywood
3-ply birch, ¼″ thick
45 spokes of No. 4 round reed, cut 20″ long
20′ No. 2 round reed for weavers
Sandpaper, coarse and fine
Wood stain
Shellac—white or clear

Procedure

Step 1. (a) Cut a paper pattern (rectangle) 12″ x 19″ rounding the corners to give an oval effect to the base.

(b) Lay the paper pattern on the plywood and trace.

(c) Cut away the corners with the coping saw, cutting on the outside of the traced line so that any irregularity in sawing may be sanded smoothly.

(d) With sandpaper smooth the sides and edges, as well as the bottom of the tray. Use the coarse sandpaper for the rougher places and the finer sandpaper for the finishing velvet smooth finish. Always do sanding with the grain of the wood whenever possible to avoid a scratched appearance on the finished product.

Step 2. Preparation of the base for spokes. If the forty-five 20″ long spokes are cut from No. 4 round reed with the diagonal cutters they can be soaking the 10 to 15 minutes needed to make them pliable while the base is being measured and drilled.

For the base, measure ¼″ from the edge in toward the center of base, and on the surface of the base draw a guide line for the placement of the spokes. On the line measure off ¾″ spaces, placing dots, as indications of where to drill for holes for spokes.

Caution. There should be an uneven number of holes if the tray is to be woven with the under-and-over weave, although the tray base shown

in the illustrations (Fig. 59) was woven with simple pairing weavers it has an uneven number of spokes, namely 45.

Select for the hand drill, a drill that bores a hole sufficiently large for the spoke to slip into somewhat easily. It will probably be about a ⅛″ drill, but trial holes on the excess wood from the corners will result in choosing the correct size.

Insertion of Spokes. When the holes are drilled and the spokes soaked, place the spokes in the holes with 1½″ to 2″ extending below the bottom of the base.

Weaving of Base Border (Figs. 7-9)

Weaving Sides of Tray. Wind weavers (fillers or reeds used to weave between or over spokes) into loops about 10″ in diameter and soak about 5 to 6 minutes.

Caution. Longer soaking raises the fibers on the reed and makes the reed fibrous and rough when dried out. If, however, weavers do dry out they may be dampened with a wet cloth or sponge. Weave simple pairing for at least a 2″ depth below the handles.

To insure uniform spacing of the handle spokes, cut two pieces of cardboard about 5″ long and 1½″ wide in the center, tapering to a point at the sides.

Moisten and bend the spokes outward at each end before placing one of these cardboards at each side, where the handles should be located. Interlace the paper under and over the spokes (Fig. 60). Continue weav-

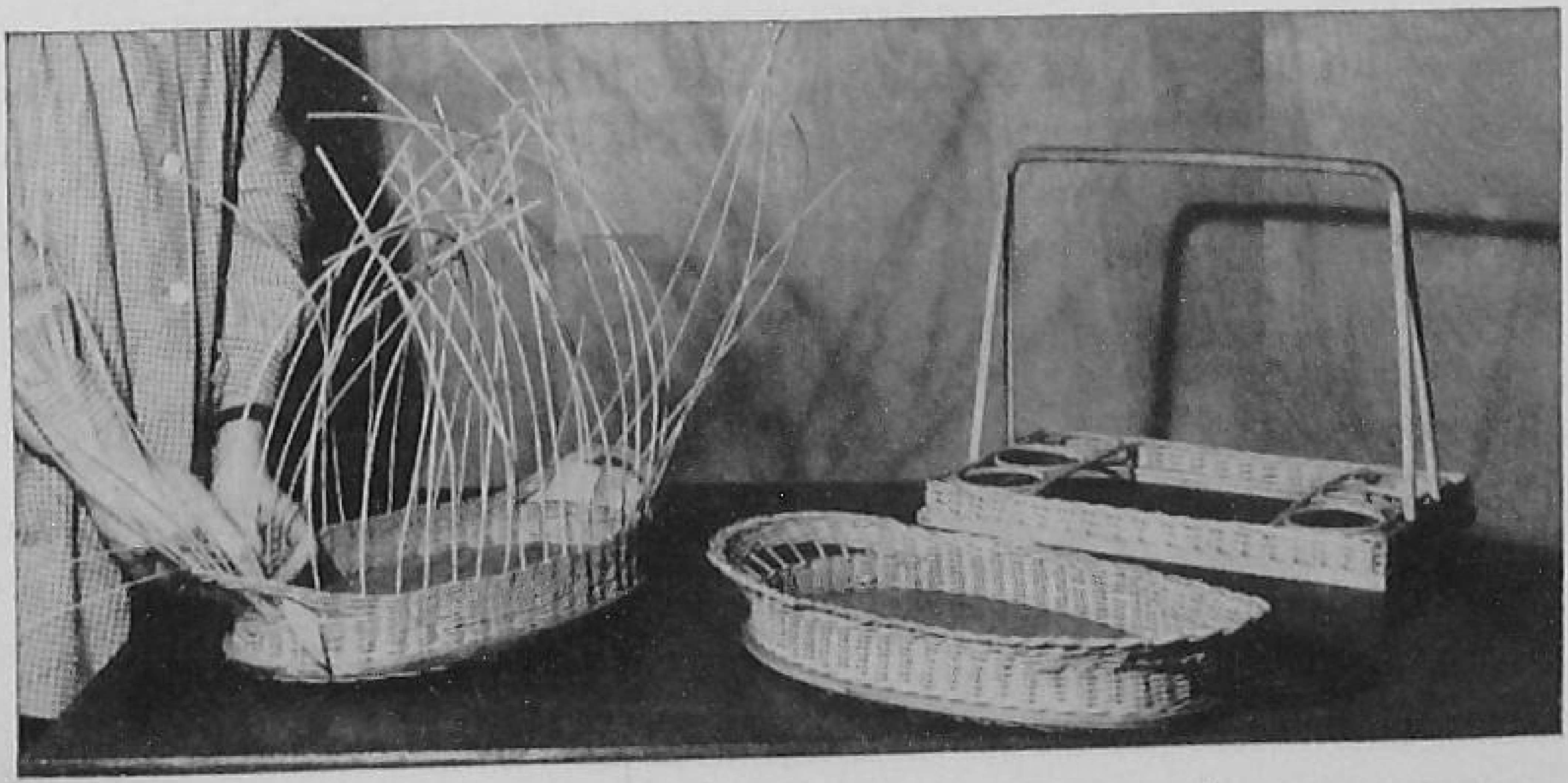


Fig. 60. Insertion of cardboard for uniform spacing.

ing as before, only carrying the weaving above the cardboard form, where the handles are to be formed.

After about four rounds more of simple pairing fasten the ends of the reed weavers by cutting them off and inserting them down in the weaving parallel to the spokes.

Border

Soak spokes until pliable, and crush them close to the weaving. Begin with any spoke and weave the flat plaited border described on page 52. Singe while quite damp. When dry, either stain the base and sides, in a contrasting or harmonizing color and apply a coat of shellac, or omit the coloring stain and apply a coat or two of white or orange shellac.

Handles

Handles of raffia wound over reed may be used on a tray with projecting side sections as shown on the tray in Fig. 61.

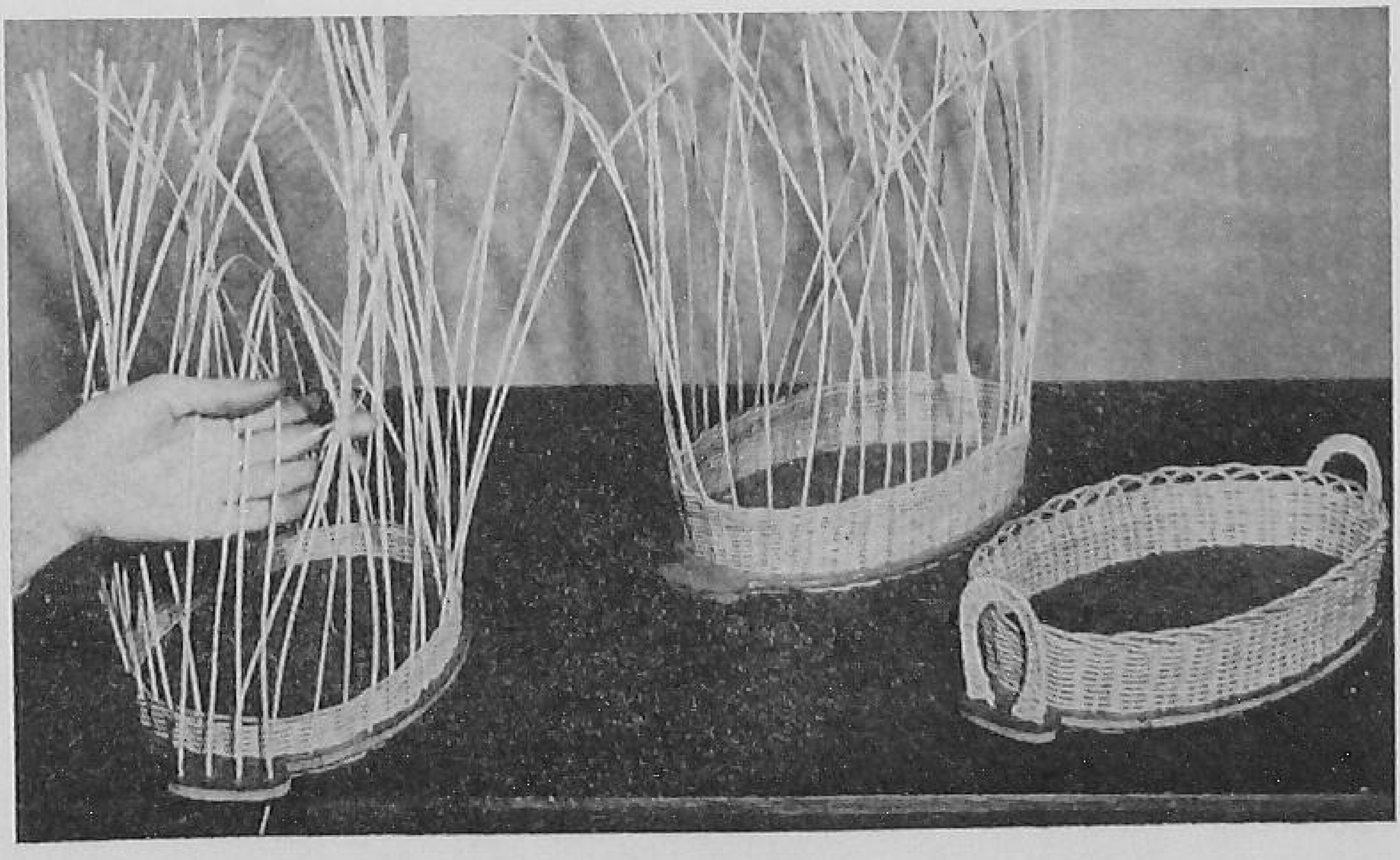


FIG. 61. Preparation for raffia wound handles.

On a combination refreshment tray such as shown in Fig. 62 the larger center section is completed before the spokes for the side sections are inserted. The woven center section measures about 3″ above the base while the six glass holders should have at least 4″ of woven sides.

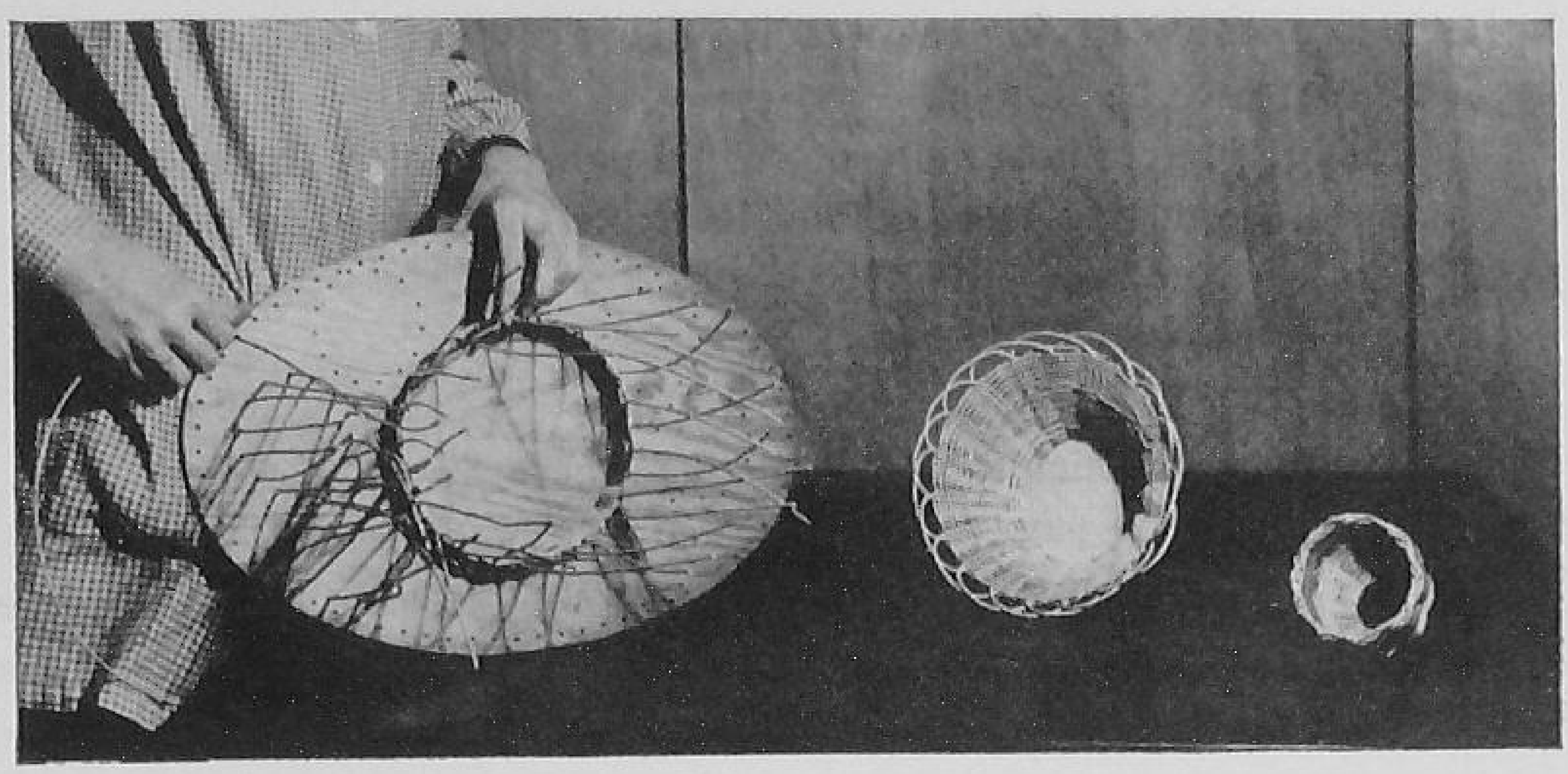


Fig. 62. Combination refreshment tray.

Beverage Tray (Fig. 63)
(willow weave or single "trac" border 14″ x 19″)

Materials

- 6″ flat-top picture frame molding ½″ thick, at least ¾″ wide, with ¼″ rabbet groove
- 14″ x 19″ double-strength glass
- 14″ x 19″ wallpaper or oilcloth
- Sheet of cardboard
- Glue
- No. 4 reed, thirty-one 22″ lengths used double or sixty-two single uprights 12″ long
- No. 6 reed, 6′ length for holders
- No. 10 reed, two 42″ lengths for handle, or two lengths of willow
- 4 yds. winding material
- 3 doz. ½″ brads
- Four 1½″ brads

Tools

Miter box and saw	Hand drill	Pliers
Frame corner clamp	⅛″ drill	Pan
Hammer	Reed cutters	

In classrooms not equipped with a miter box and saw or frame clamp, a glassed picture frame with as near a flat outer surface as it is possible to obtain may be drilled to hold the reed uprights.

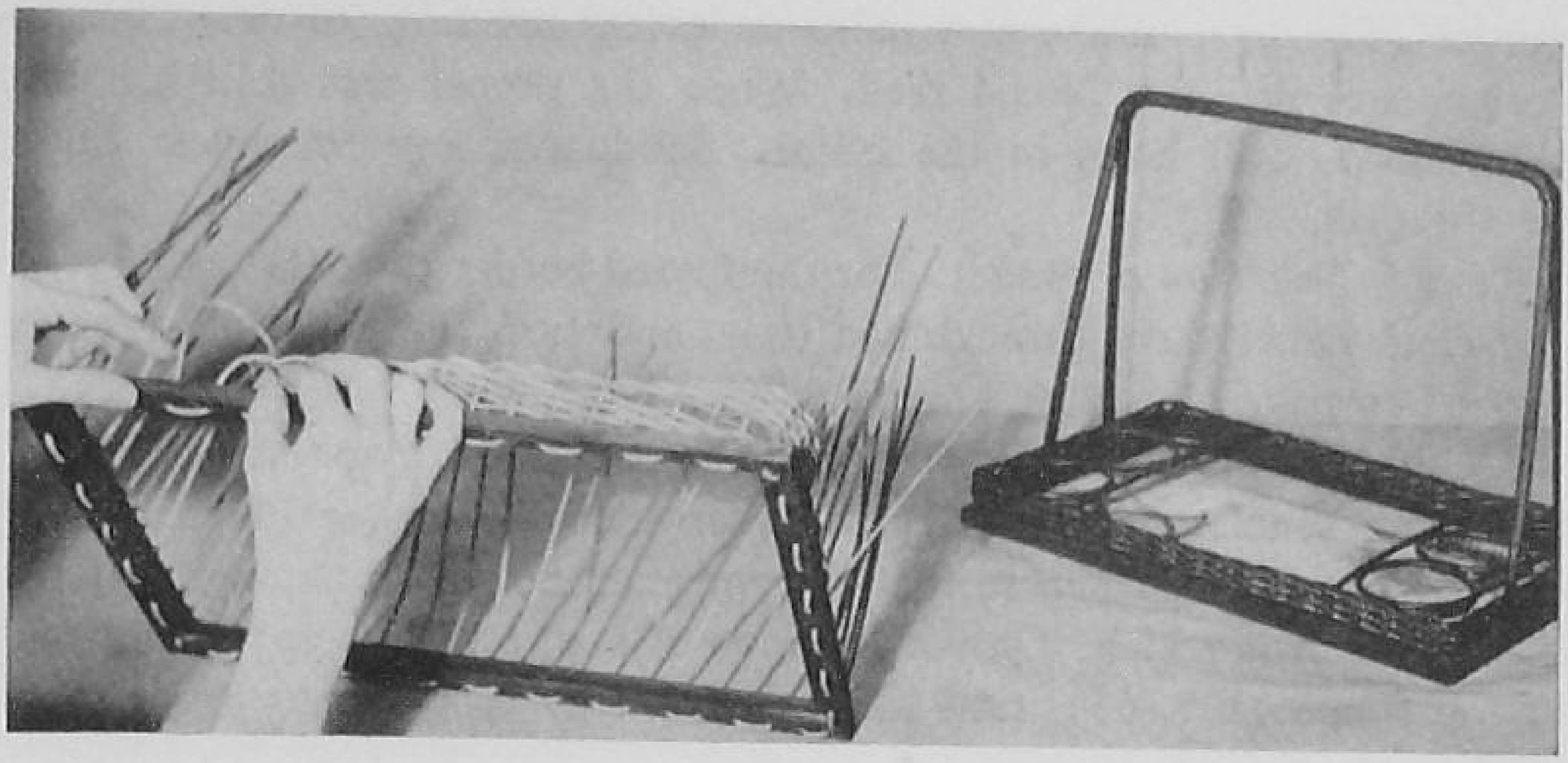


FIG. 63. Base border, with double length spokes.

Procedure

Step 1. Check double-strength glass measurements, and plan frame molding cuts to fit glass, not too tightly. It is much easier to cut molding to the size of the glass than to attempt to decrease the measurements of the glass. Accurate right-angle corners can be made with the aid of a miter box and saw. Mitered corners should be glued as well as nailed.

Step 2. Number of spoke holes. Since there are at least three methods of inserting spokes in a tray frame of this type, the method chosen will determine whether an even or uneven number of holes will be needed. On trays where a conventional footed border at the bottom of the frame would add to the beauty and design of the tray, either an even or uneven number of holes may be drilled. But if a less conspicuous base border is desired, as shown in Fig. 66, an even number of spoke holes is required in which double-length spokes are inserted in adjacent holes. Drilling only three quarters of the thickness of the frame and gluing the separate spoke ends into the holes will result in a flat, smooth base, as is apparent on the underside of the finished tray in Fig. 68. In this method either even or an uneven number of holes may be used.

Step 3. Location of Spoke Holes. On a ¾″ wide tray frame, make a line a ¼″ from the outer edge and determine the location for the corner holes, so that no holes need be drilled at the joining. If the corner holes are set ½″ along the line from each joining, the resulting space will approximate the distance between spokes along the lines. These should be approximately 1″ apart to allow the interlacing of the willow or trac

border (Fig. 69). Make test holes on excess molding, to determine the correct size drill for No. 4 reed. When the proper size drill has been ascertained, drill holes in the frame. Sandpaper any roughness caused by the drill.

Step 4. Insertion of spokes. For the footed border soak the single spoke ends and insert them through the base, and turn the ends under as described on page 15.

Double-length spokes were used for the beverage tray shown in Fig. 63. Thorough soaking is necessary in order that the center of each spoke can be bent close enough so that the ends can be pulled through adjacent holes without cracking. Only a flat loop of reed remains on the underside of the frame (Fig. 63), thus allowing the tray to rest very close to the table surface.

The spokes can be arranged so as to give extra strength to the corners by crossing a loop over the corner joining, as shown on the upper right-hand corner in Fig. 63, or the spokes can be inserted so that adjacent holes are located on the one strip of molding as on the lower right-hand corner in Fig. 63.

Step 5. Willow or Single Trac Border. Spokes must all be thoroughly soaked and pliable before starting the border. Care should be taken to gage the beginning correctly and to see that the finishing strokes are woven into the beginning. Follow the pattern of the border carefully, so that the joining point is in no way visible.

A 3″ trac border requires spokes about 10″ above the frame. For No. 4 reed spokes, set about 1″ apart, measure 3″ above the frame and with the round-nose pliers, squeeze each moistened spoke so that it flattens at a right angle to the frame. Accuracy in this measurement will aid in keeping the border the same depth throughout. Starting along a side, which is easier than at a corner, bend a spoke down behind the next spoke to the right, in front of the next, behind the next, in front of the next, etc., until the spoke end is reached. Bring the spoke end to the outside of the frame and press on a slant, until the end rests on the frame (Fig. 64). Repeat, working each spoke in turn in the same way, carefully threading the finishing strokes of the border so that the pattern is continuous (Fig. 65). Take care that only sufficient reed is allowed at the corners for smooth turning, as too much slack will cause a bulge (Fig. 65). When all the spoke ends have been interwoven, the height of the loops and the squareness of the corners should be checked. Before trimming the projecting ends off, on a slant, make any adjustment necessary.

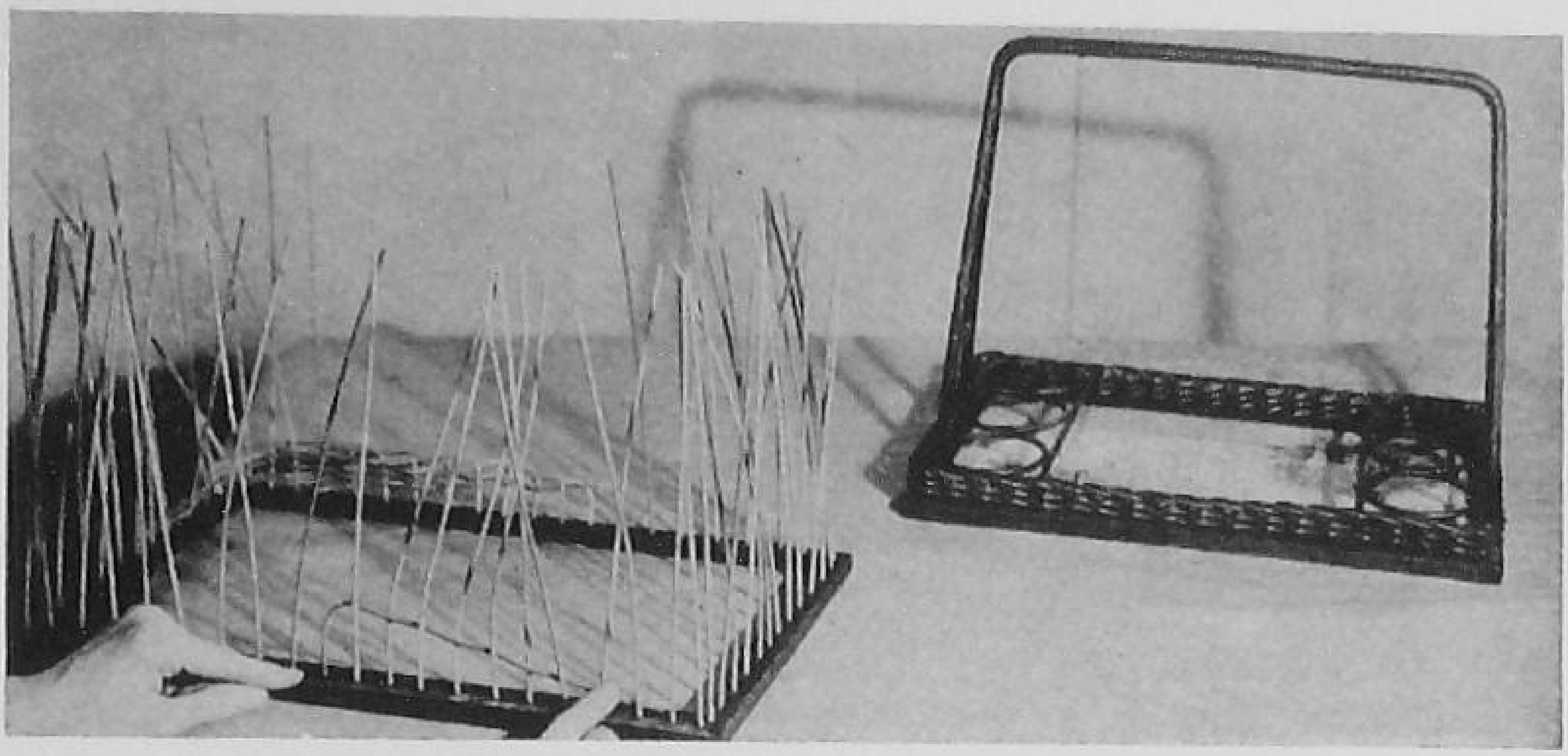


FIG. 64. Start of willow weave border (single trac).

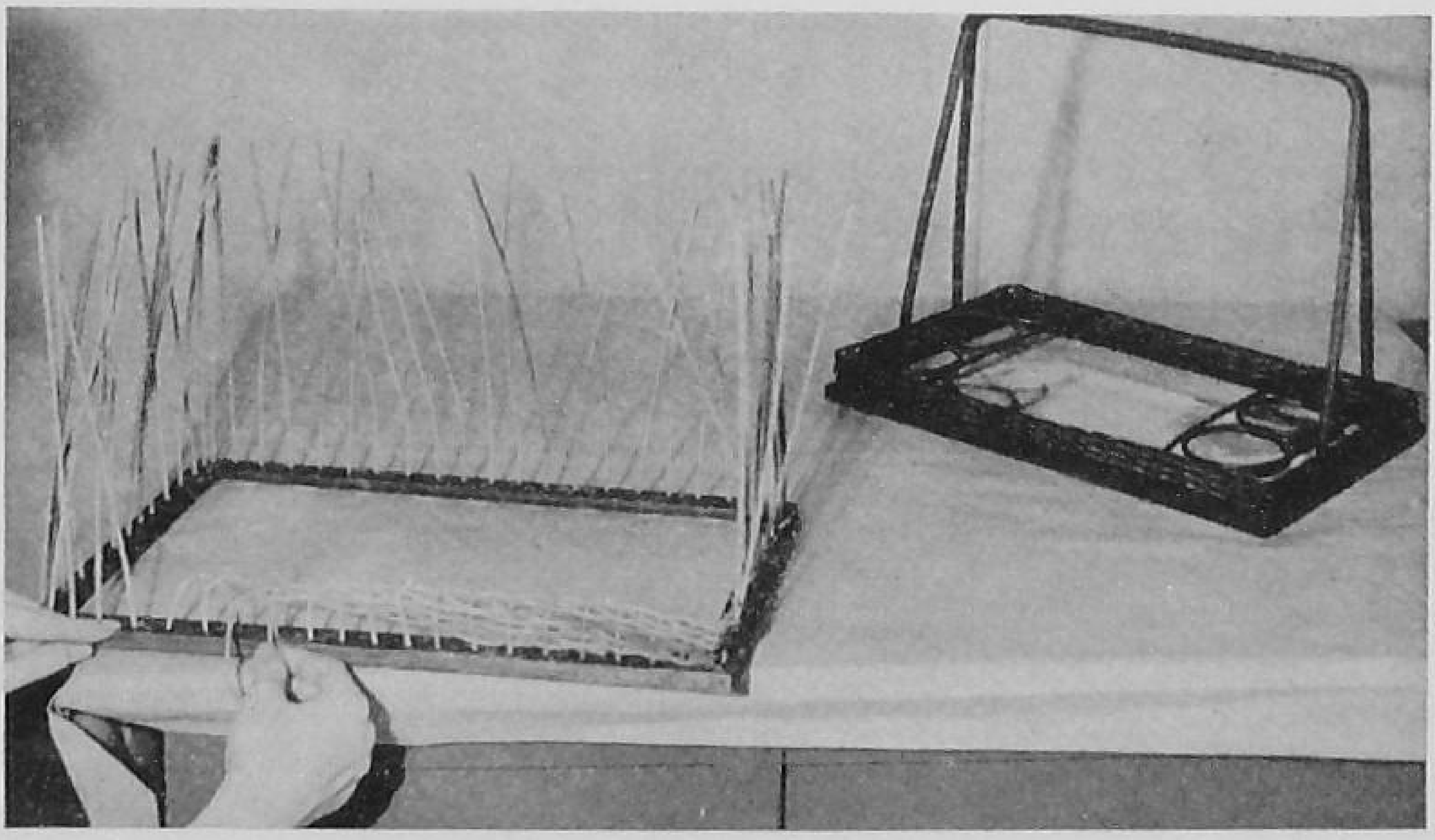


FIG. 65. A 3 inch trac border.

Step 6. Glass Holders. Cut No. 6 reed in two and thoroughly soak it. Wind the reed around three inverted glasses and tie it in order to let it dry in the desired position (see diagram, Fig. 66). Use four passes of winding material to hold the adjoining loops with the ends secured to the reed border by thin metal brads. Fasten a length of No. 6 reed across the tray at either side, just touching the glass holders, with thin metal

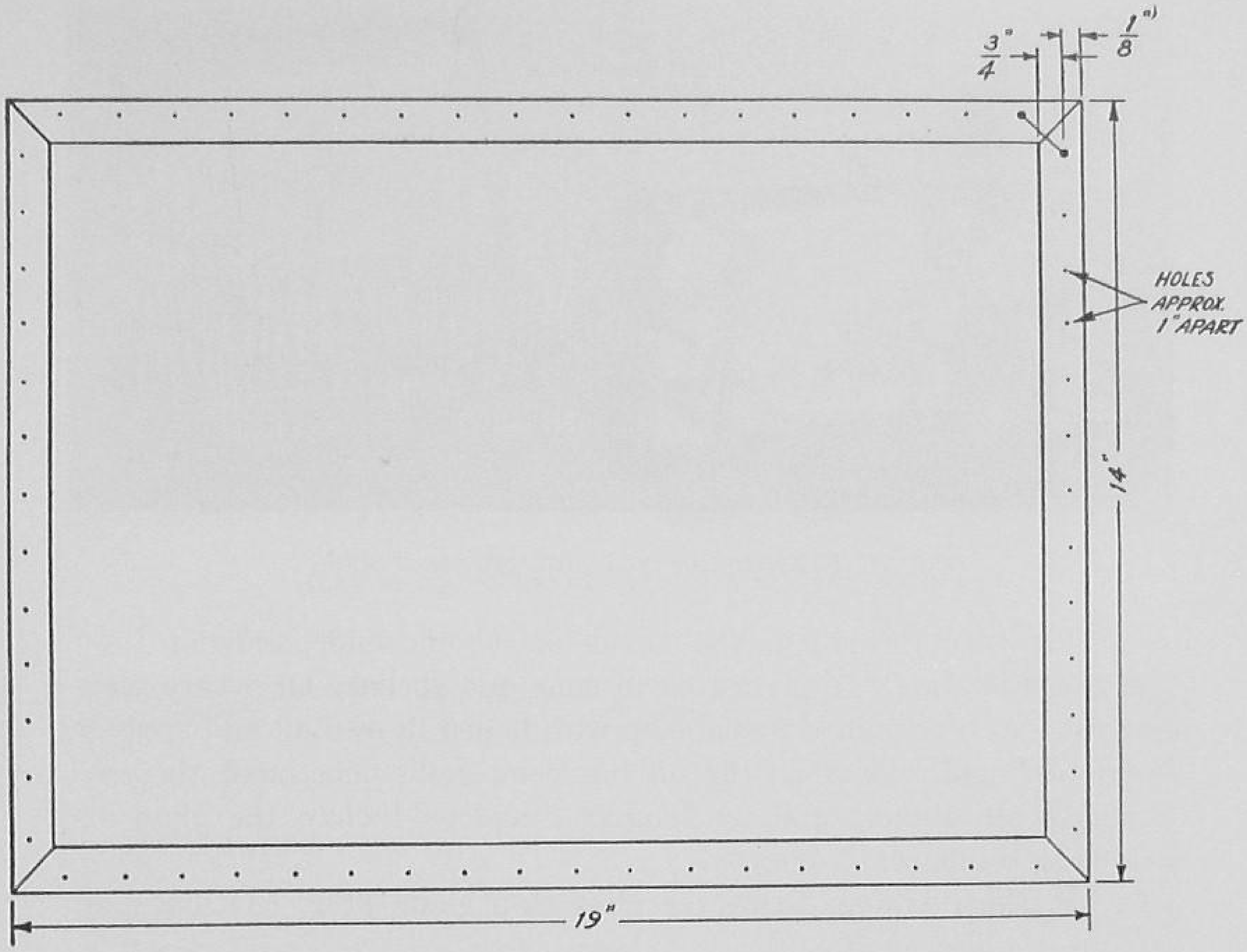


FIG. 66. Diagram of beverage tray base.

brads through the reed circles and also at its joining with the reed border (Fig. 67). Pliers are used to press the brads into place.

Step 7. The Handle. Students find it easier to tie the soaked handle, attach it, and allow it to dry in position, before wrapping the two strands together across the top. Point the ends of the No. 10 reed somewhat and insert it in the border until the ends rest on the frame. Use the awl to open the woven pattern sufficiently to allow the handle to go through. The pointed end can be snipped off with the diagonal cutters and the blunt end then glued to the frame. It may be necessary to drill through the frame and also the ends of the handle, in order to center the long, thin brads needed to insure maximum strength. After the handle has been attached, and is thoroughly dry, catch one end of the soaked winding strand back between the two handle pieces so that the winding overlaps it at least an inch, and wrap the two pieces of the handle together. When the opposite side of the handle is reached, carry the end back between the

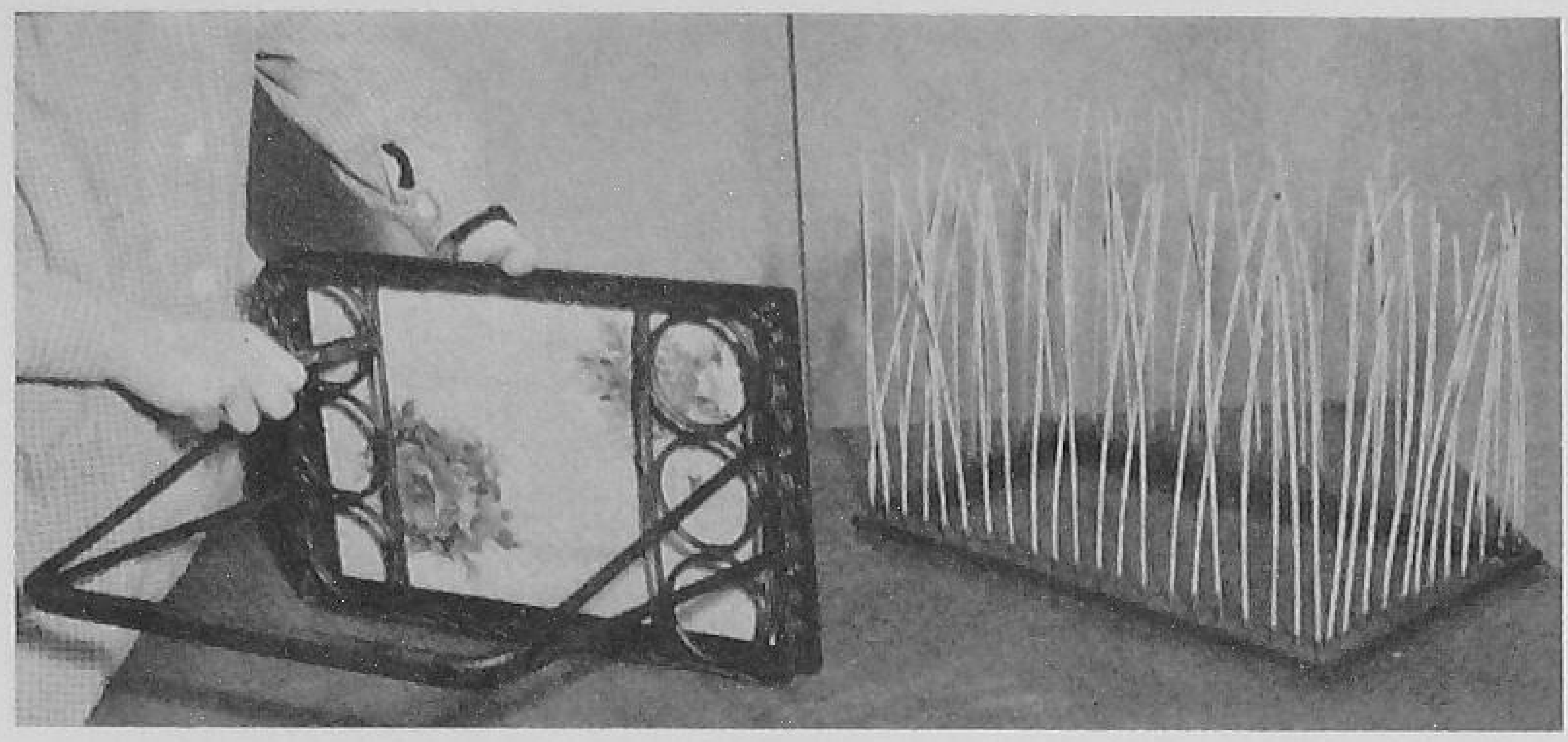


Fig. 67. Fastening the reed with thin metal brads.

two handle pieces, bring it to the outside on the underside, and snip it off.

Step 8. Finishing. Apply a coat of stain and shellac. Or a very pleasing finish can be obtained by rubbing with boiled linseed oil and applying a coat of liquid wax when the oil has completely penetrated the reed. Of course all staining and finishing is completed before the glass and oilcloth or wallpaper is inserted.

Step 9. Glass Lining. Using the glass as a guide (Fig. 68), cut wall-

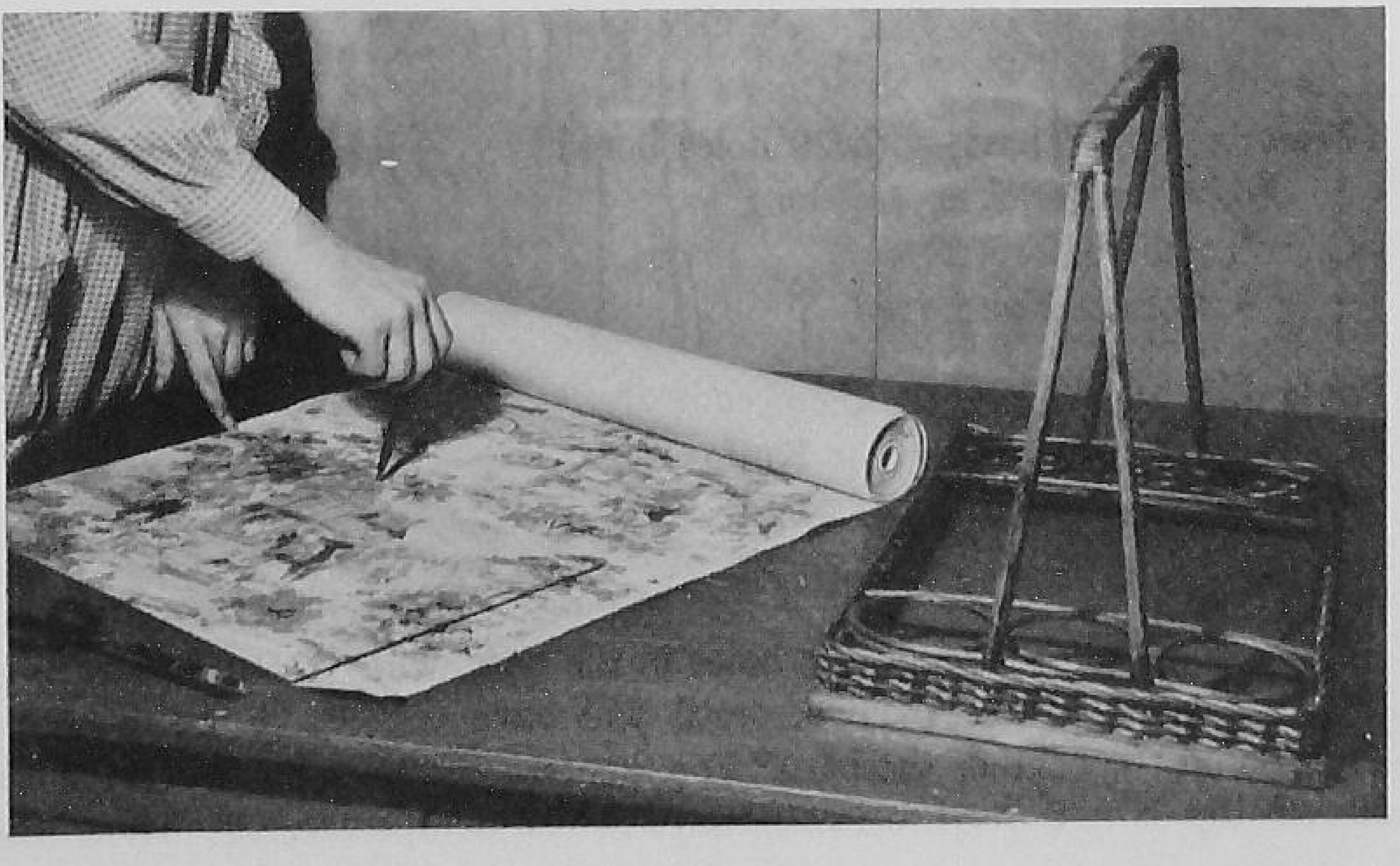


Fig. 68. Wallpaper lining.

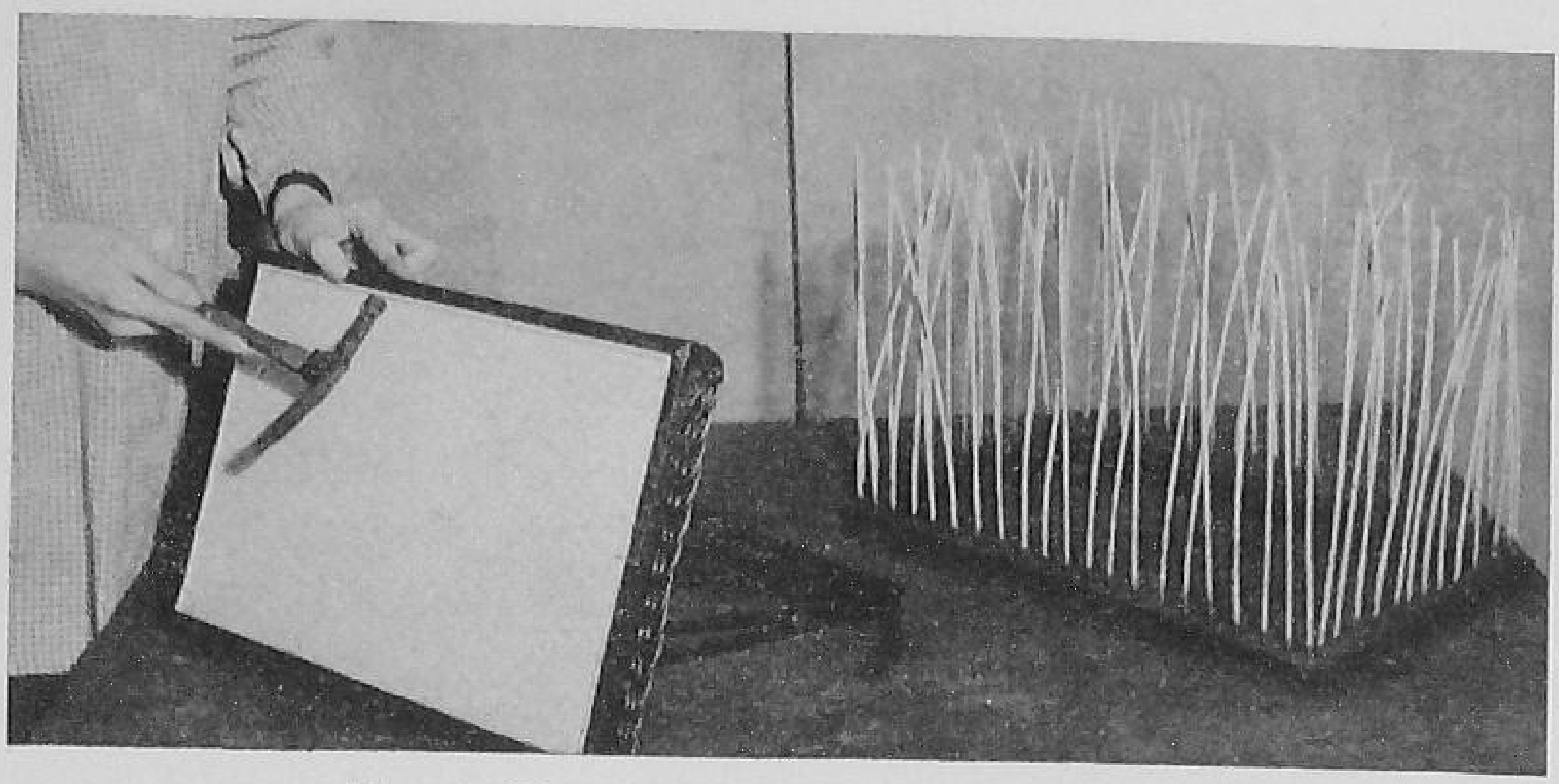


FIG. 69. Fastening the bottom with thin brads.

paper so that the motif or picture is centered or at opposite corners. A layer of cardboard serving as a lining is held in place by pieces of reed fitted into the corners and fastened by thin brads tapped through the reeds into the frame (Fig. 69).

Flower-Pot Holders

A hand-woven flower-pot holder filled with small plants makes a most attractive centerpiece for the table. It may be made in different sizes (Fig. 27).

Materials

Material for 8″ base, with 29 holes bored
29 No. 4 reed spokes, 14″ long
One strand No. 0 reed
8 or 9 strands No. 2 reed

Tools

Reed cutters	Knife
Awl	Pan

Procedure

Insert the spokes through the holes in the base, with the ends extending 2½″ below, and leave them so until you have completed the overedge loop around the edge of the base. For this one weaver is used. Insert the end of the No. 0 reed between any two spokes extending below the base, cross the edge of base to the top, and carry the weaver completely

around the next spoke extending above the base, then to the right and completely around the next spoke extending below the base; repeat, crossing the edge of the base from top to bottom, until you reach the starting point. Then turn the base upside down and repeat the process, carrying the weaver around the spokes that were not used before, and crossing the weaver of the first row. Cut and end the weaver as you began; the spokes turned in at the base will hold these ends. The weave is a very simple one and makes a pretty finish. Still holding the base with short ends of reeds extending outward, pass each spoke to the right, in front of the next spoke and to the inside of the base; make sure that the ends are at least ½″ inside.

Having completed the base, proceed with the weaving of the basket. Insert three long weavers of No. 2 reed, one at the right of three successive spokes. Do five rows of triple weave, then finish off one weaver, and turn the end in and down beside the spoke. Continue with two weavers in over-and-under weave, for nine rows. When the nine rows are completed, insert an extra weaver, and again do three rows of triple weave. End the weavers behind the same spokes from which they started. Then cut the ends and turn them in and down beside the spokes on the inside of the basket.

Finish the edge by passing each spoke to the right and behind two spokes. This brings all the spokes to the outside of the basket. Regulate the top edge to the same size all around. The ends of the spokes are then crossed to the left over one spoke, and inserted at the first or second row of the over-and-under weave alternately, depending upon the spaces made by the weaving. Cut the ends on a slant, allowing them to rest at least ¼″ against the spokes.

This model, made on a larger base and with additional rows of weaving, makes a very convenient workbasket.

Bread Basket
(spokes inserted into edge of base)

Materials

3″ or 4″ square birch plywood
No. 2 reed—11 spokes for 3″ base
13 spokes for 4″ base, 10″ long
Second set 8″ long
No. 0 reed—¼ lb.
Glue

Tools

Coping saw	Hand drill
Sand paper	Drill for No. 2 reed

Procedure

Step 1. Mark a circle on the plywood square and with a coping saw remove the corners. Remove the roughness of the edge with a rasp or coarse sandpaper, before locating the spoke holes.

Step 2. An uneven number of holes is required if the over-and-under weave is desired. But the basket can be made entirely of simple pairing weave, using an even number of spokes. Trial holes for the proper size can be made on the excess wood from the corners. Hold the wood disc in a vise clamp and bore the holes in the edge of the disc to a depth of ¾″.

Step 3. Dip the spokes into the glue and insert them in the holes (Fig. 70). Allow the glue to dry thoroughly.

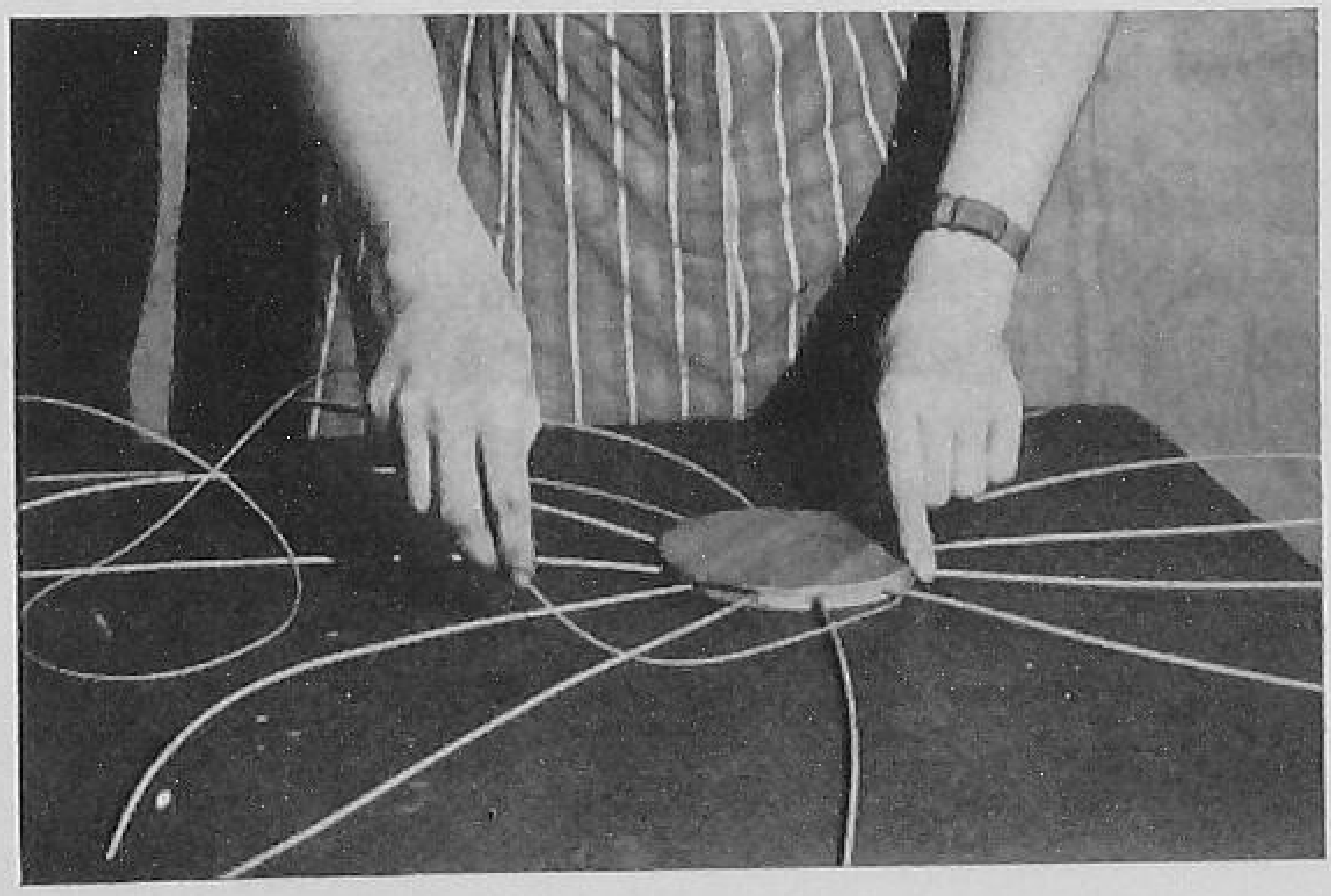


FIG. 70. Bread basket, step 4.

Step 4. (a) If the base has an uneven number of holes, hold a single length of No. 0 reed, which has been soaked 10 to 15 minutes, against the edge of the disc (Fig. 70) and carry it over and under the successive spokes until the woven section measures about 2″. Allowing the wood center to rest on a flat surface (Fig. 71) while the over-and-under sequence is being worked aids in obtaining a flat bottom on the bread basket. Insert an additional spoke beside each original spoke and push

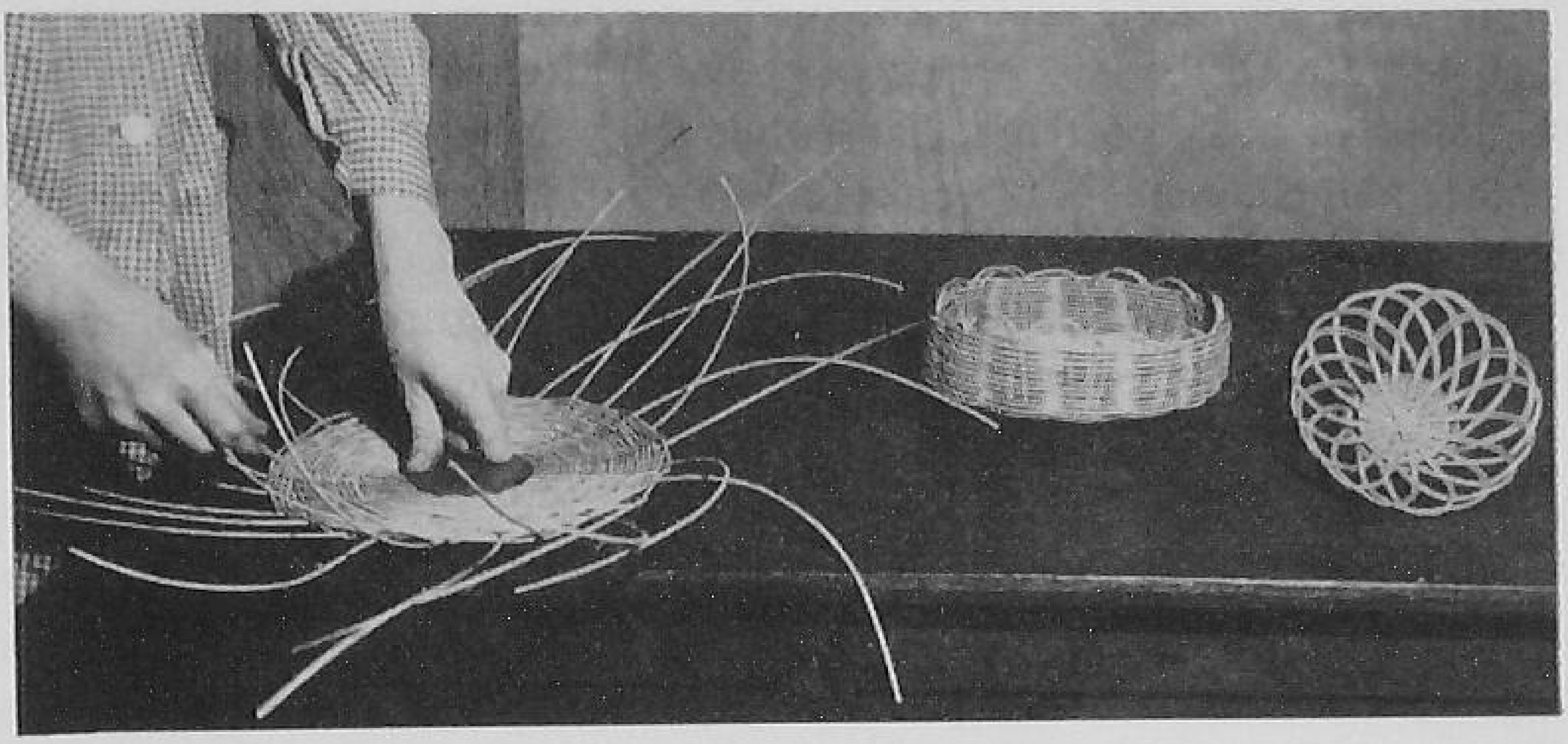


FIG. 71. Rest the wood center on a flat surface.

it toward the center. After making about four complete rounds in which the two spokes are treated as one, separate them and continue the over-and-under weave until the wood center and woven section measures about 10″ in diameter.

(b) If the base has an even number of holes fold a length of No. 0 reed which has been soaked 10 to 15 minutes and slip the loop over a spoke (Fig. 18), to provide the two strands necessary to do the simple pairing weave for 2″. Insert an additional spoke beside each original spoke and push it toward the center. After making four complete rounds in which the two spokes are paired as one, separate them and pair them

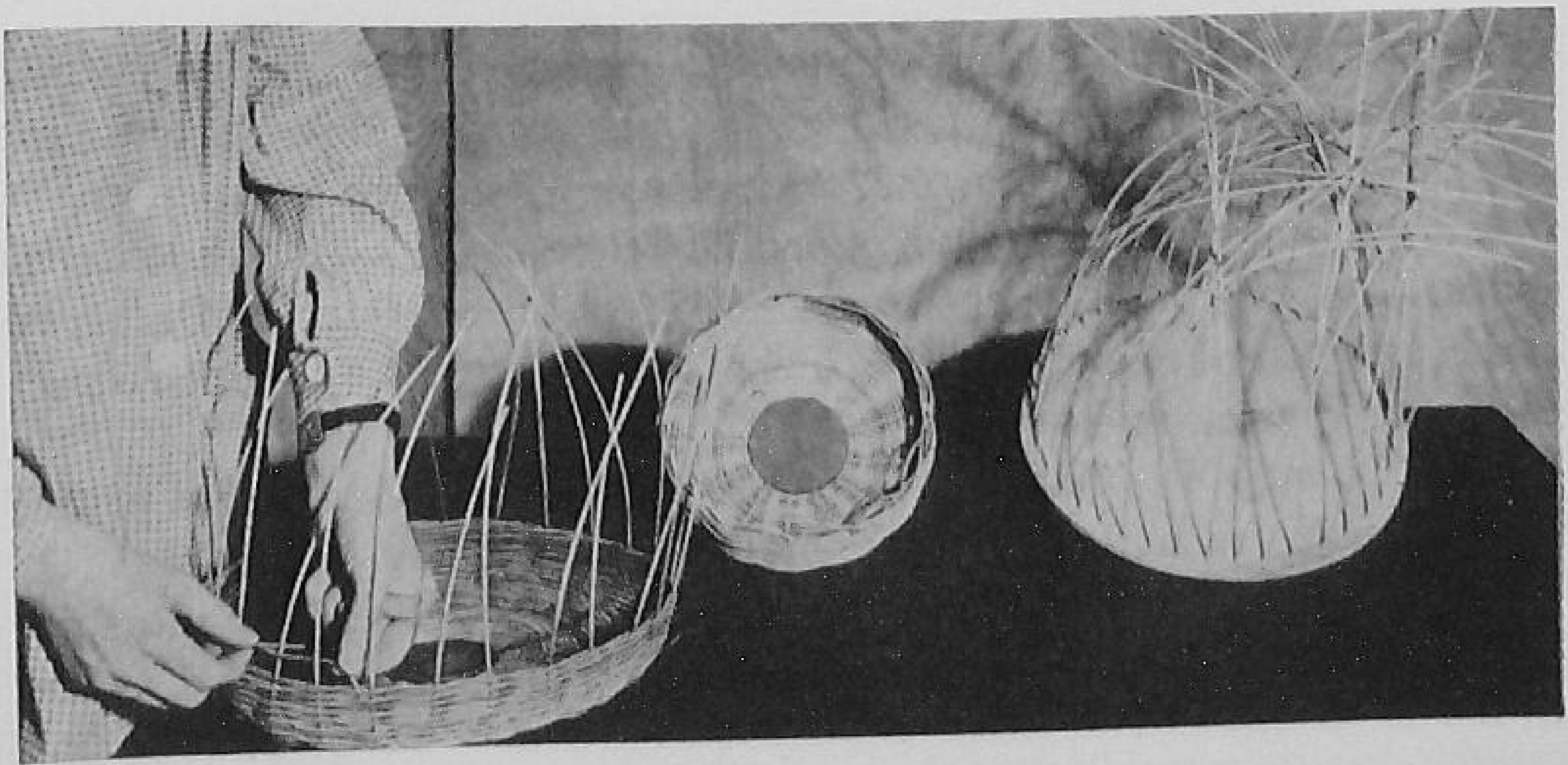


FIG. 72. Bread basket with simple pairing weave.

singly until the wood center and woven section measures about 10″ in diameter. In this weave also a very flat bottom is assured if the base is allowed to rest on a flat surface while the pairing weave is being done.

Note that the number of spokes now radiating from the woven edge is just twice as many as those radiating from the wood center.

Step 5. Shaping the Sides. When the basket measures 10″ in diameter, soak the spokes sufficiently to allow bending them upward to form the basket sides. In doing this be careful that the base and the glued end of the spokes do not become moistened, or warping of the base, or loosening of the spokes, may result. A container deep enough so that the basket

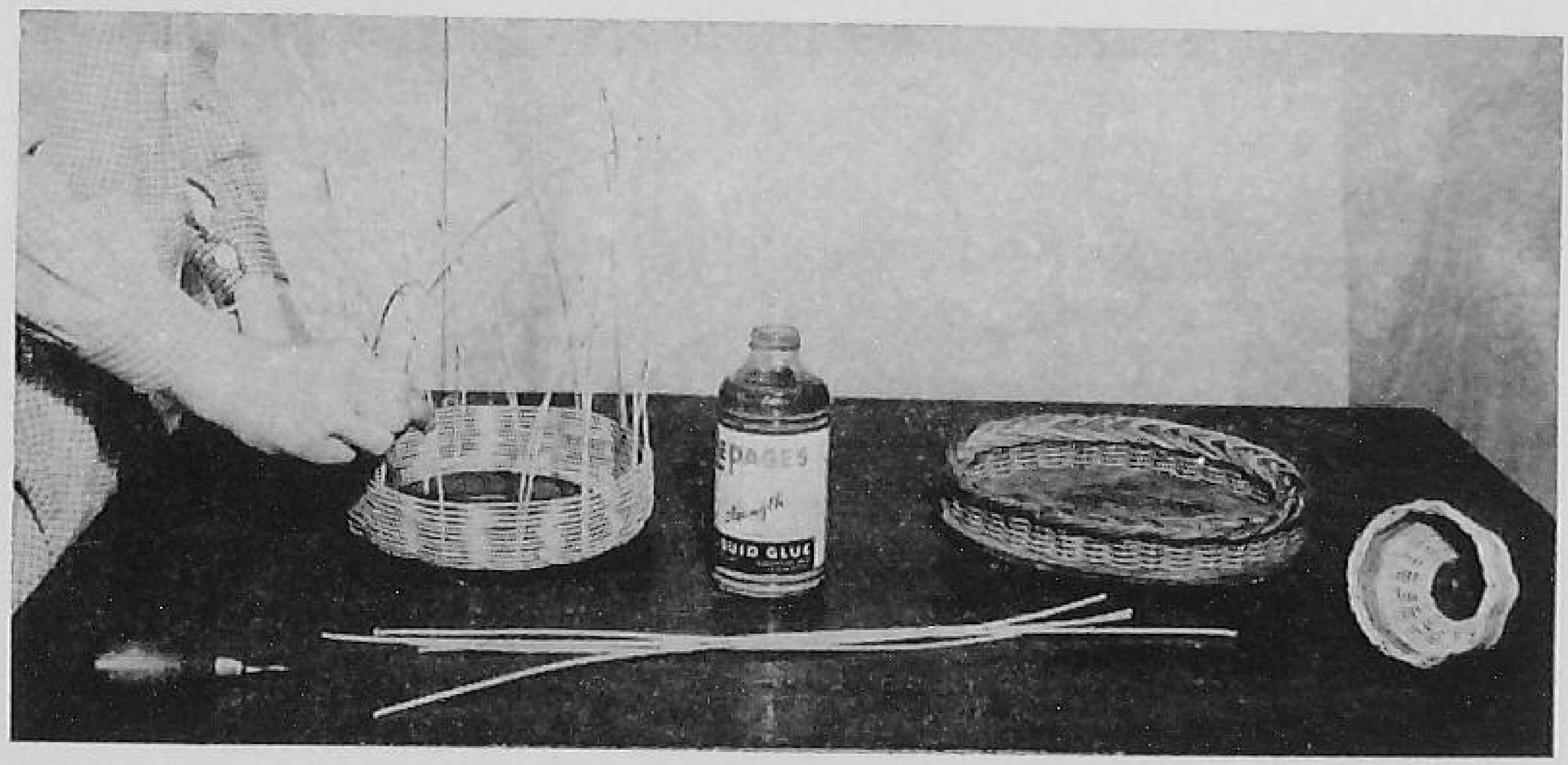


FIG. 73. Open border, first step.

can be rolled in it like a hoop without the center portion coming in contact with the water is much faster and results in more uniform moisture than using a wet sponge to soak each spoke. Bend the soaked spokes upward quite close to the weaving, and complete at least 2″ of additional rounds. The ends of either the single weaver of the over-and-under weave or the two strands used in the pairing weave must be inserted down beside the upright spokes (Fig. 72).

Step 6. Border Treatment. The border possibilities on a basket of this type and size are numerous. Any of the open borders is suitable. On the simple pairing woven sides open border III is especially pleasing; or a very open lacy type of border may be made by additional spokes on one or both sides of each original spoke, thus making spoke groups of two or three (Fig. 73). Open border I may be done with the right

spoke in each group. Then the original spoke may be turned down in the open border II sequence. With two spokes already inserted the remaining spoke, which in a three-spoke group, would be the left one, could be carried to the front of the other two and inserted in the Open Border III sequence. In turning down the various spokes be careful that the resulting loops are of uniform height (Fig. 74). If the spoke ends

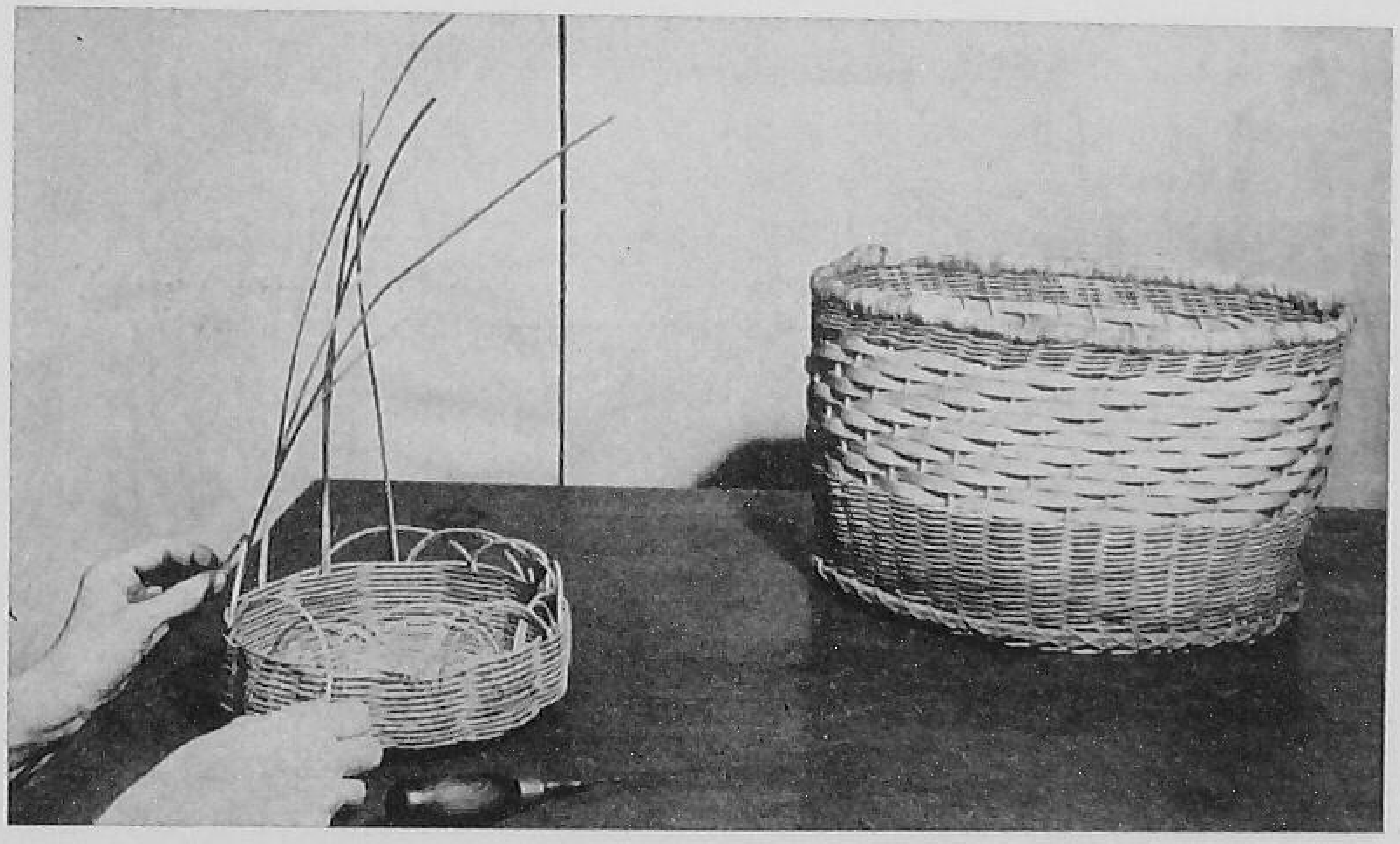


FIG. 74. Open border with additional spokes. Raffia wrapped border.

are inserted down through the weaving to the point where the sides of the basket fold upward they can be pulled to the outside and cut off with the reed cutters with very little difficulty. The awl will be found to be very useful in enlarging the space through which the spoke ends may be passed. After both sides of the basket are singed a coat of shellac will preserve the natural color of the reed. An application of stain will darken the reed strands. The wood center is an ideal location for decalcomania transfer of appropriate size.

Reed Hot-Plate Holder (Fig. 75)

Materials

8 strands of medium reed, No. 3 or No. 4, of desired length
16 strands medium reed, about half of the above length
Several lengths of fine reed, No. 1

Liquid glue
Stain
Quick-drying varnish or enamel

Tools

Side or diagonal cutters
Pointed awl
Pan for soaking reed
Gas plate or torch for singeing

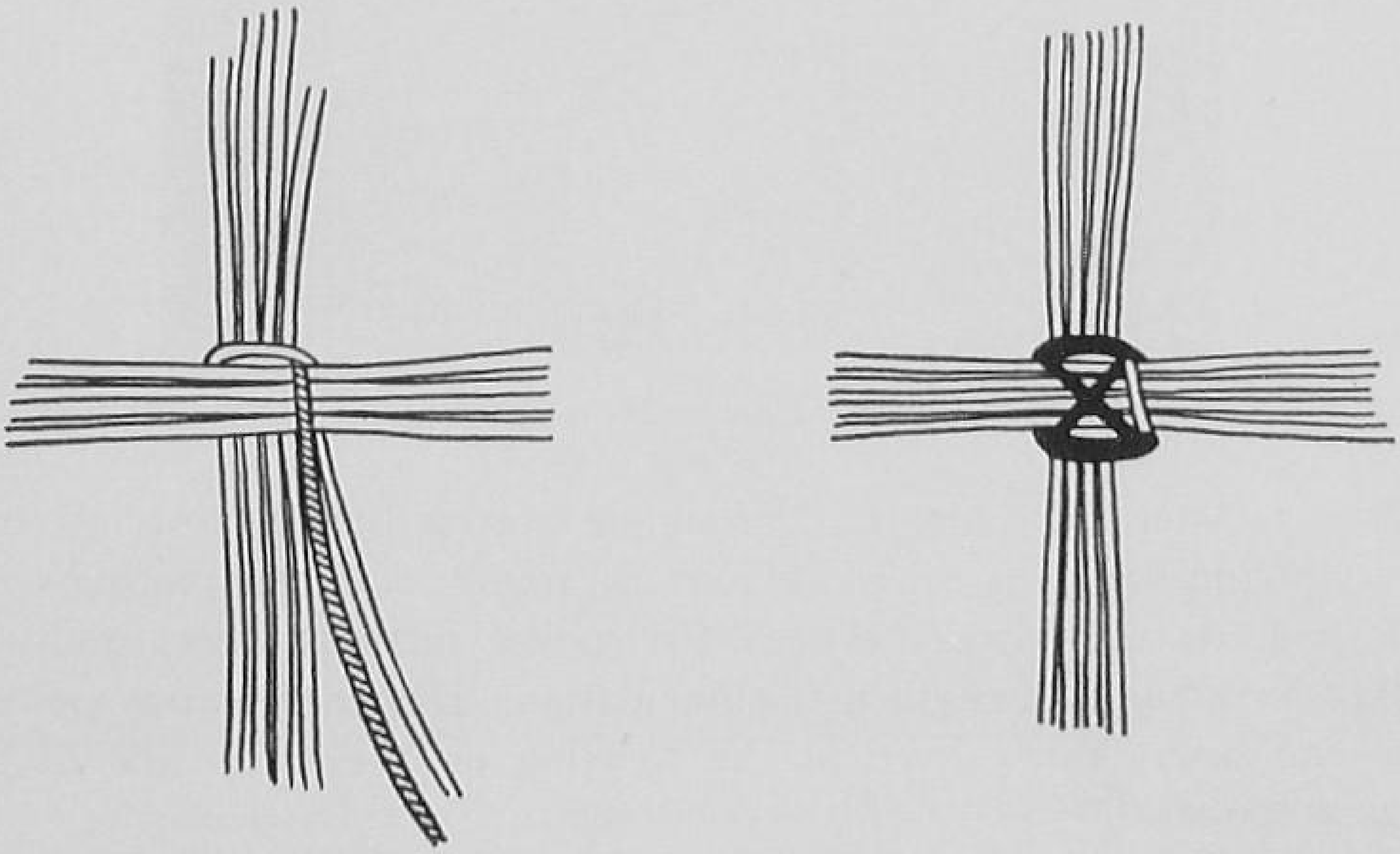


Fig. 75. Reed hot-plate holder, step 1.

Procedure

Spokes are made of heavier reed, and the weavers are of the finer reed.

Step 1. Take the eight strands of No. 3 or No. 4 reed, from 18 to 30″ long, depending on the size of the mat desired. Soak the reed well. Take four pieces in each hand and place them at right angles through the centers, as shown in Fig. 75. Tie them in place with No. 1 reed, weaving over and under, around the center four or five times. So that there may be an even pattern, cut off one of the resulting sixteen spoke ends after the center is finally tied in place.

Step 2. Spread the remaining fifteen spoke ends equal distances apart, and with well-soaked No. 1 reed start an over-and-under weaving. Fit each new row of weaving carefully in toward the center to eliminate open spaces between the weavers.

The mat may be kept flat if the weaving is done on the edge of a table or other flat surface, and the spokes bent down in weaving (Fig. 76). Insert each new weaver along the side of a spoke.

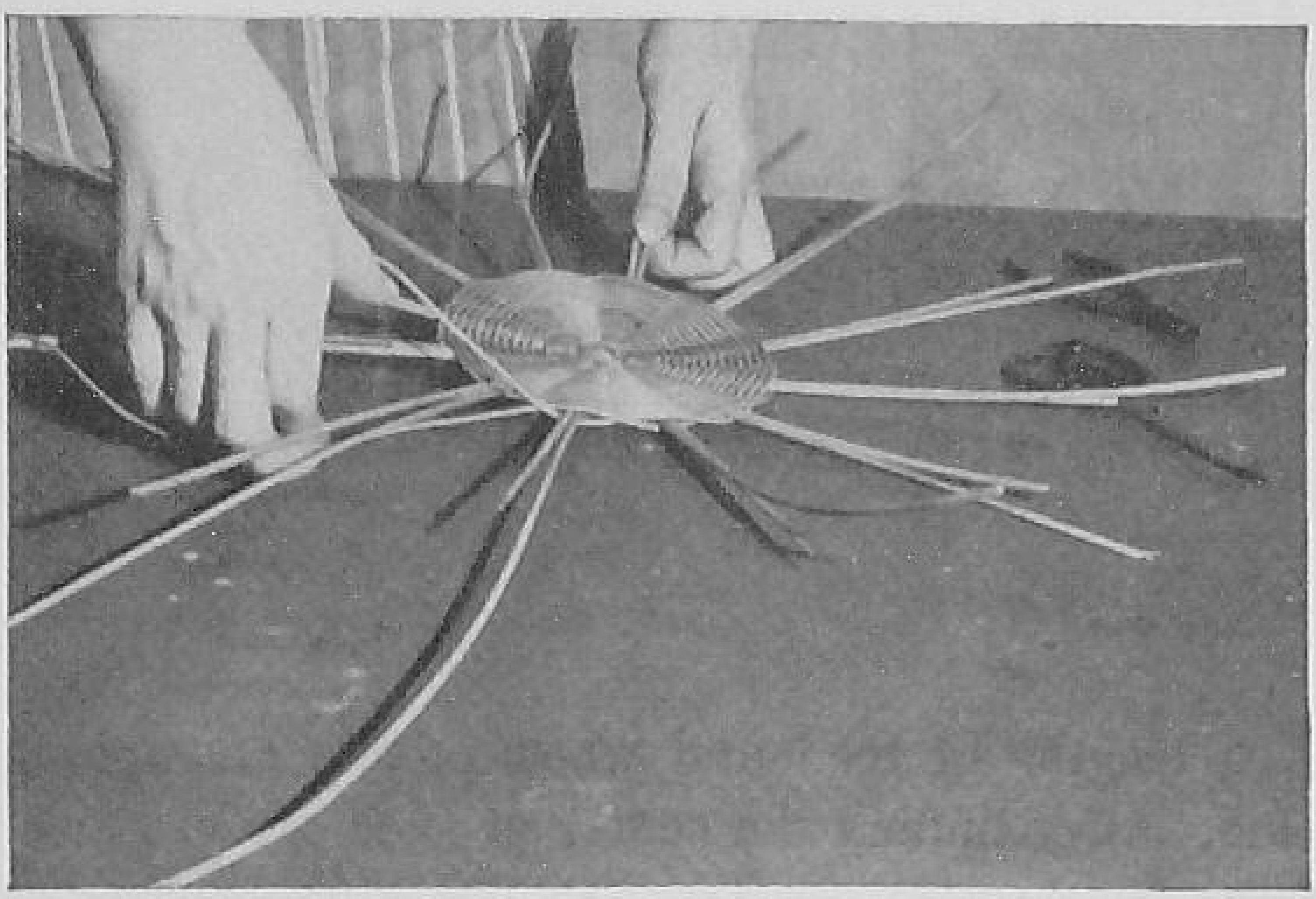


FIG. 76. Reed hot-plate holder, step 3.

Step 3. After doing about 2″ of simple over-and-under weaving, make a variation in design by completing several rounds of simple pairing weave.

Step 4. As the spaces between the spokes increase insert additional spokes in order to strengthen the foundation. Dip these extra spokes in glue and insert them down in the weaving on the same side of each original spoke.

Continue several rounds of pairing weave, treating the pairs of spokes as one.

Step 5. Separate the spoke pairs and continue the pairing weave until the desired size is obtained. Insert the final ends of the two weavers along the side of two separate spokes.

Note that the separation of the spoke pairs results in doubling the number of pairing twists needed to complete one round of the mat. Colored reed may be introduced to excellent advantage in pairing weave.

Step 6. The edge of the mat may be finished by bending over the remaining ends of spokes and pushing them down along the side of another spoke, in open border I, II, or III sequence (Fig. 28), or by adding short lengths to form a very lacy looped border such as is shown in Fig. 74.

Step 7. When the mat is completed and dry, use a blow torch or gas flame to singe the fine bits of fiber left hanging from the reed. Do not use candle flame, as soot will blacken mat. Nip off with side-cutting pliers

any loose ends of weavers. Finish the mat in a natural tone with several coats of clear varnish or white shellac, stain it with water or oil stain, and when dry give it one or more coats of quick-drying varnish.

Card Basket

Materials

16 lengths of No. 3 reed, 25″ long
4 lengths of No. 1 reed

Tools

Reed cutters	Knife
Awl	Pan

Procedure

Soak the 16 lengths of reed and when pliable arrange the pieces in groups of fours. After finding the center of each group place two groups of four across each other so as to form an X. Place another group of four vertically across the X and the remaining group of four horizontally across the vertical group (Fig. 77). It is a practical plan to lay the spokes on

Fig. 77. Card basket base.

a flat surface and hold all the ends down flat until after several rounds with the weaver have been completed.

Place the end of a length of No. 1 weaver under the first group that forms the X. Carry the weaver over the first group of four, under the next group of four, over the next, and under the next, until at least four parallel rounds have been completed. At the beginning of the fifth round, run the weaver under the groups of four over which it was carried for the first four rounds, thus alternating the binding of the basket foundation.

After completing the second four parallel rounds, repeat the over-and-under sequence of the first set of four parallel rounds. Upon completion of this third set the diameter of the woven center of the basket should be about 4″.

Now divide the groups into twos and pass the weaver over two, under two, etc., for four complete rounds. (See Fig. 77). Then run the weaver under the groups of two over which it was carried in the previous rounds, thus separating the spoke groups and making the spaces between them uniform. Cut the end of the weaver on a slant and insert it down in the weaving along a spoke group.

Weaving the Lattice Edge

Carry a spoke group (2 pieces) to the right over the next spoke group, under the next group, over another group and under again. Leave the loop loose and a couple of inches high but hold the ends down close to the weaving.

Treat each spoke group in the same manner, though after the first three the loops need not be left so loose. Tighten the first three loose loops after weaving the final three spoke groups in proper sequence through them.

Foot of Basket

Now round the sides of the basket with the hands and turning it upside down with the loose ends upright form a foot by doubling a No. 1 weaver and slipping the loop over a spoke group, thus providing two weaving strands. Simple-pair each spoke group in sequence for about six complete rounds and end the weavers beside successive spokes (Fig. 78). There should still be 2 to 3″ of upright spokes remaining.

Start with any spoke group and turn it to the left over the next group to it and down back to the next (Fig. 79). Be careful to hold the two

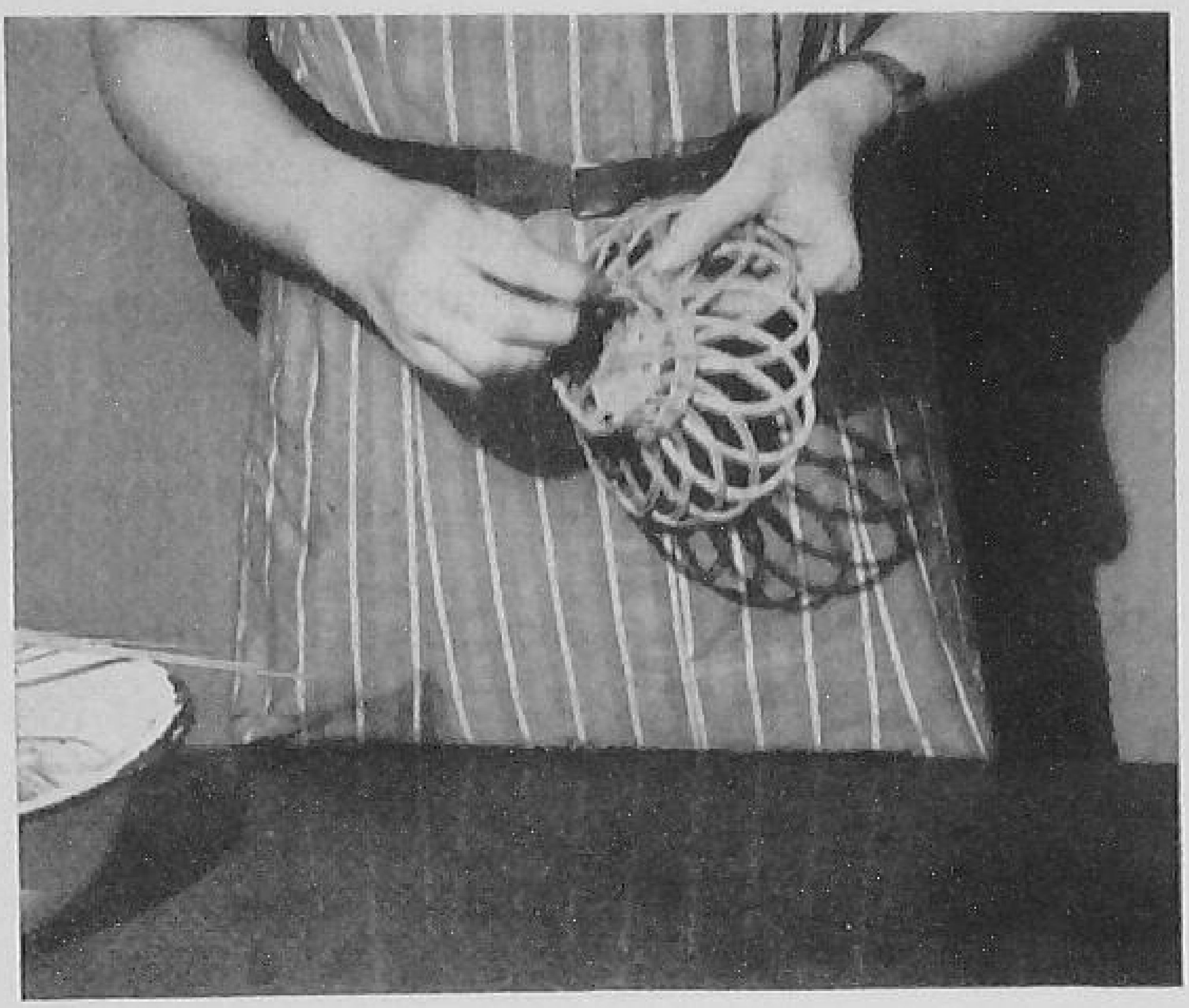


FIG. 78. End the weavers beside successive spokes.

spokes in each group parallel and keep them from twisting about each other, or the basket foot will not be uniform. Turn each spoke down and trim off all spoke ends, as well as any loose fibers, with the diagonal cutters (Fig. 80).

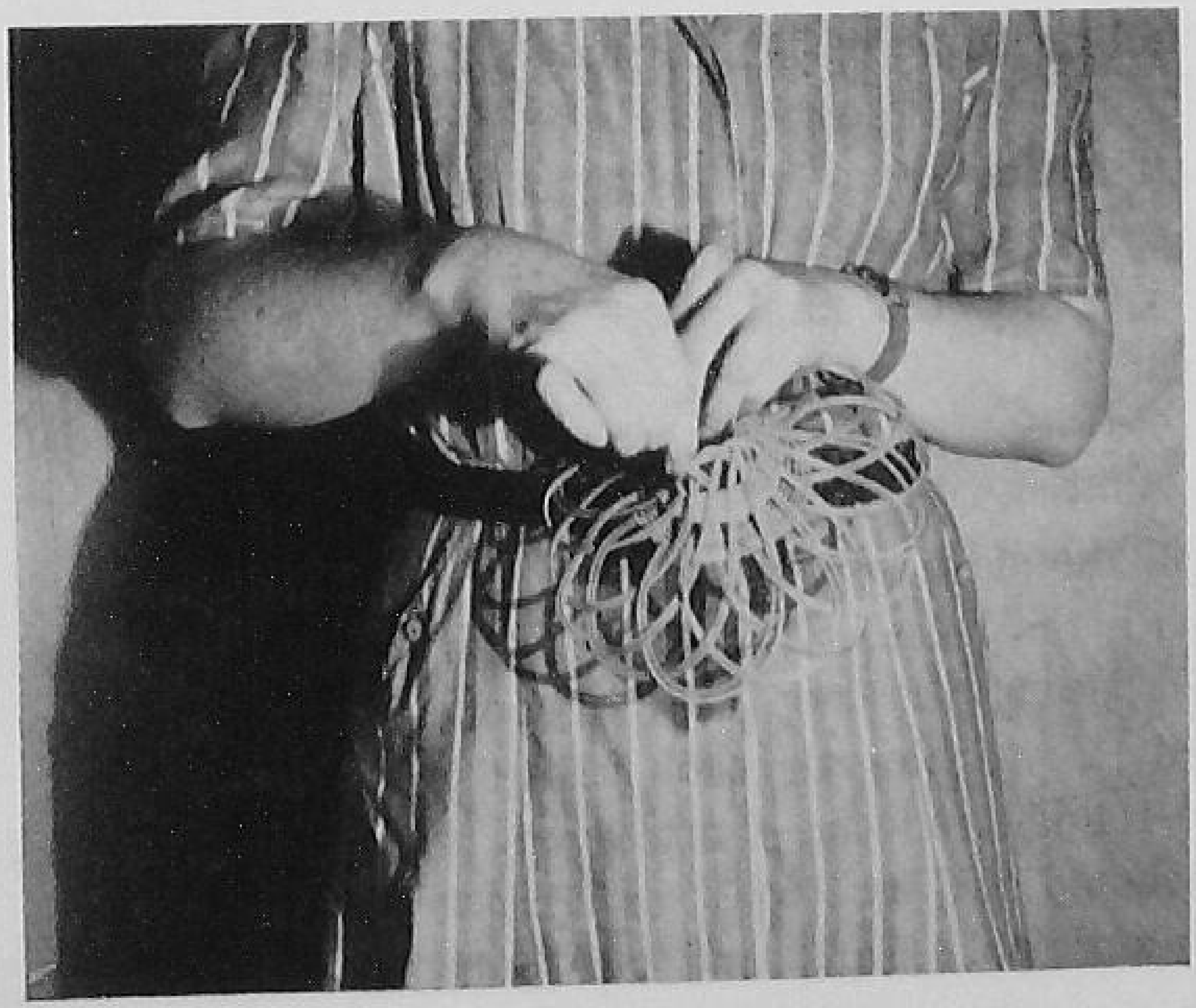


FIG. 79. Turn the spoke group to the left.

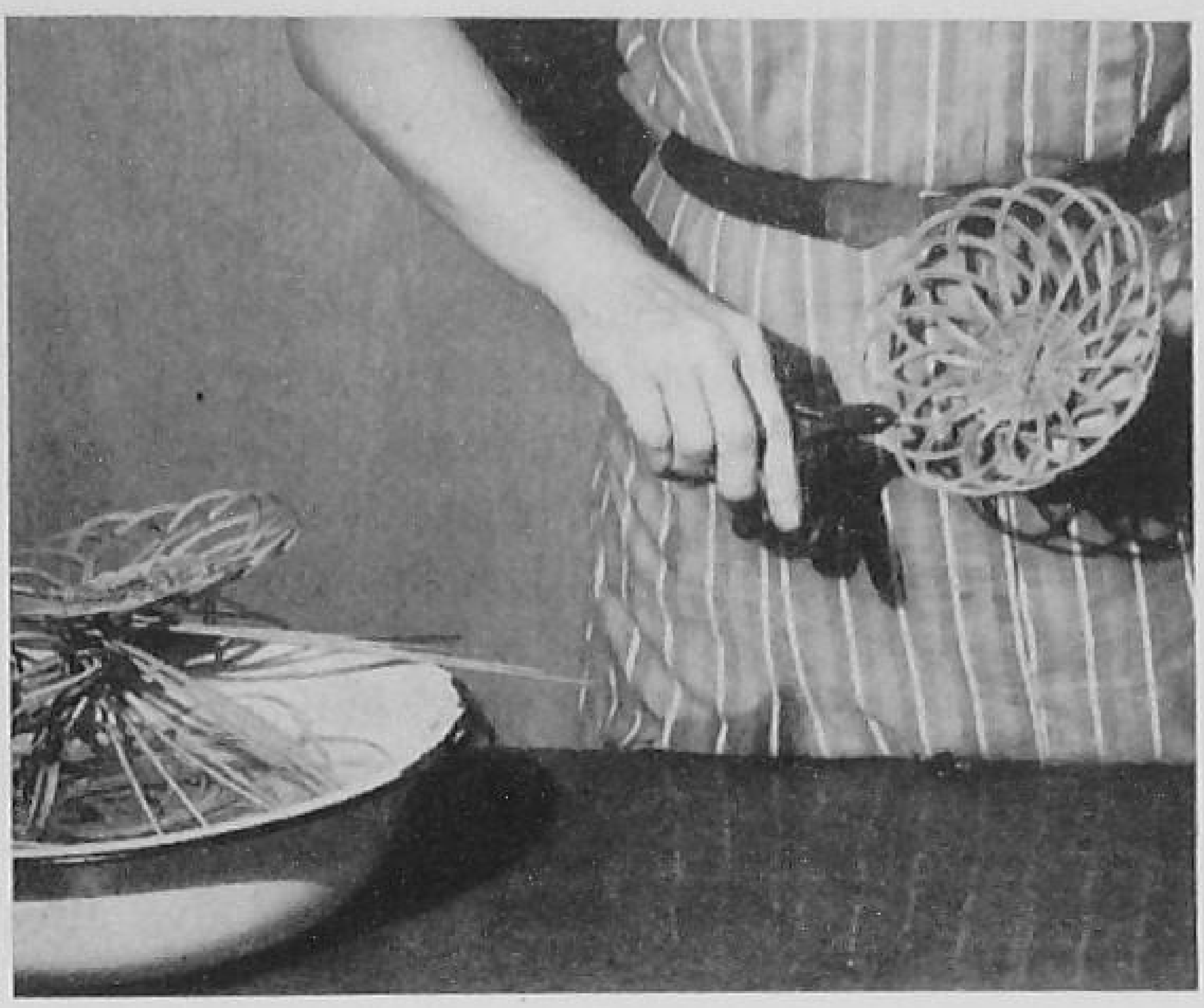


FIG. 80. Trim off all loose fibres.

Before applying stain or shellac, singe both sides of the basket to remove any hairlike fibers.

Tea Tile or Mat

Materials

- 8 spokes No. 2 reed, 16–18″ long
- 1 spoke No. 2 reed, 9″ long
- 1 strand No. 0 reed
- 3 strands No. 1 reed

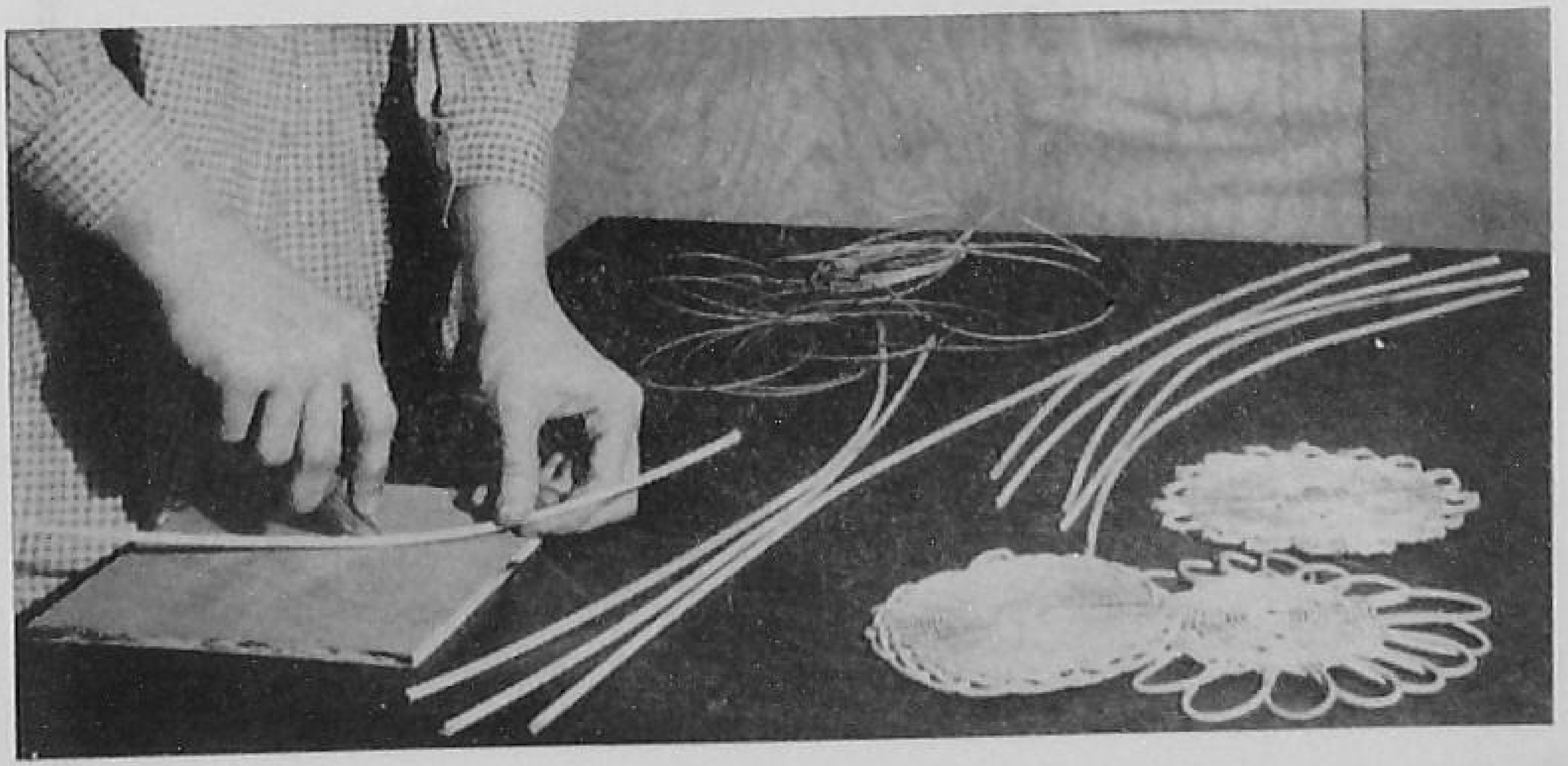


FIG. 81A. Split four of the eight spokes.

Tools

Reed cutters

Pan for soaking reed

Procedure

Soak reed as directed under "General Instructions." Find the centers of four of the eight spokes and with an awl or a knife make a small split in each (Figs. 81*A* and *B*) long enough to run the remaining four spokes through. Have all ends even. Place the 9″ spoke at the side of the longer ones, with one end just through the split spokes, thus forming a half spoke (Figs. 82*A* and *B*). This gives an uneven number of spokes, required for under-and-over weave. When this has been done, take the strand of No. 0 reed and cut it in half to make two weavers. Insert the ends of the two weavers in the split spokes, one on each side of the group of five already passing through the split ones (Fig. 82*B*). Cross the weavers over the center of the spokes, carry them to the back, and cross. Weavers are now in the same position as at the start (Fig. 83). Cross left weaver 1 over the group of 5 spokes, over weaver 2, and behind the next group of spokes (Fig. 84). Repeat this movement with weaver 2. This is pairing around groups—do two rows of it. Separate each spoke and do simple pairing weave for two rows to

Fig. 81B.

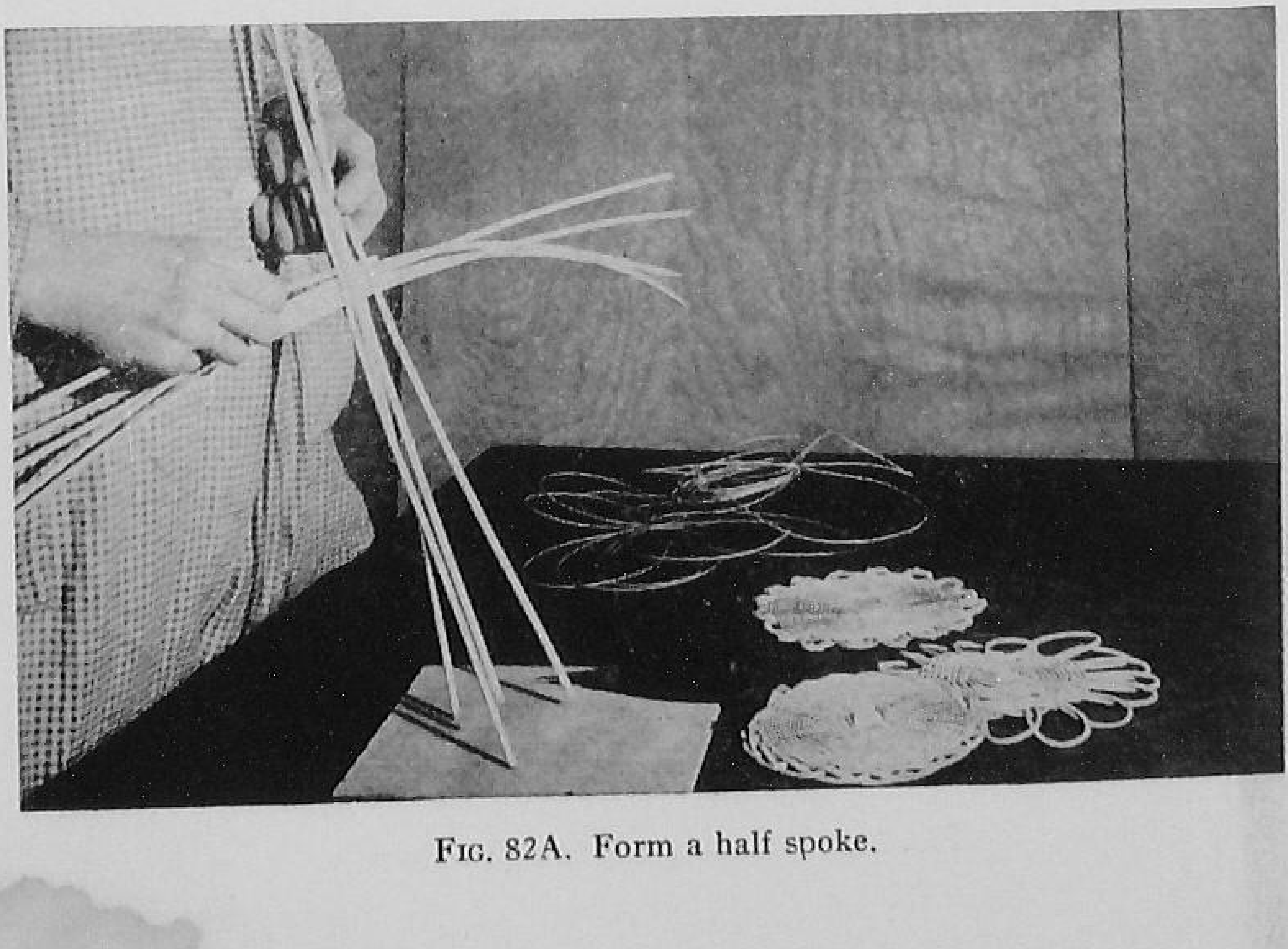


Fig. 82A. Form a half spoke.

make a tight firm center. Cut and piece both ends of No. 0 reed with No. 1 reed and continue pairing for 7 rows or until the diameter measures 3″—but do not cut weavers. Make sure to end each weaver behind the spoke from which it started. Hold both weavers together and pass them in back of the next spoke. Keep weavers parallel and do 6 rows of double over-and-under weave. Then change back to pairing weave for 4 rows or until the diameter measures 5½″. Cut and end the weavers by tucking them in and down beside 2 successive spokes.

Make the border by carrying each spoke behind 2 spokes, with the curve regulated to the desired height and 1½″ inserted in and down beside the second spoke. Cut the ends on a slant before inserting them and use the awl for stretching if they do not go easily into the woven section. Singe and finish with shellac or lacquer.

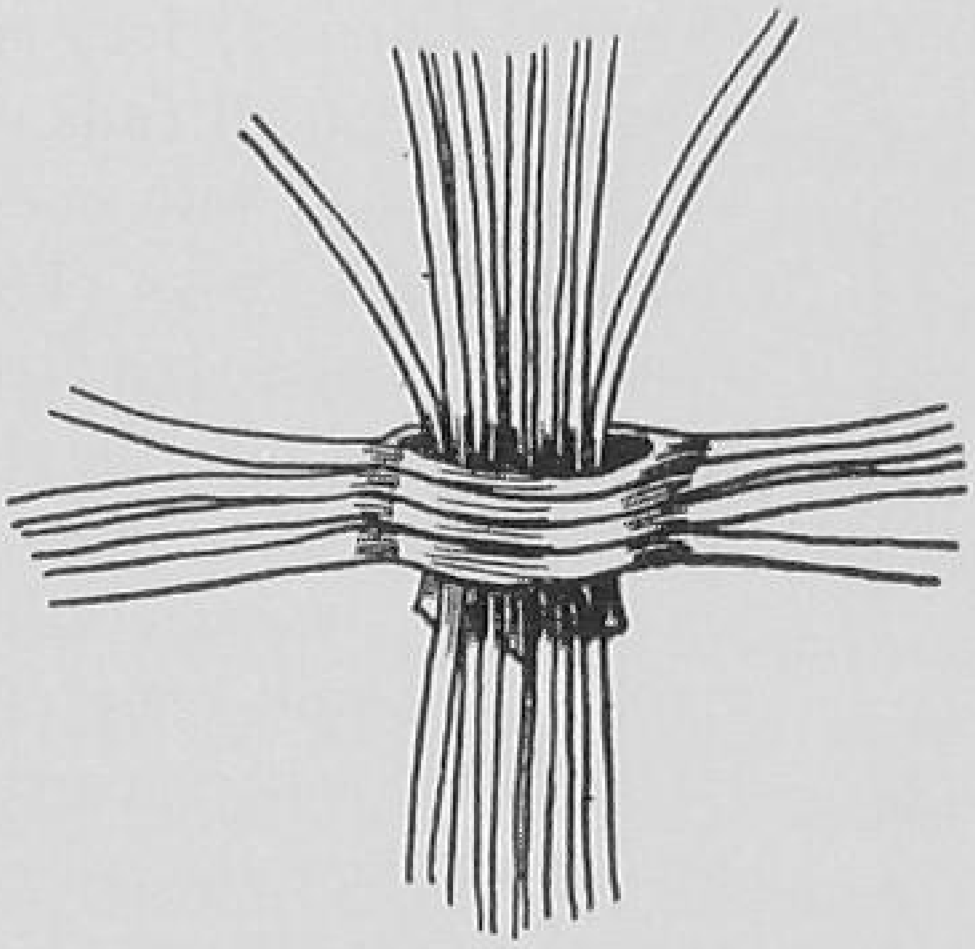


FIG. 82B.

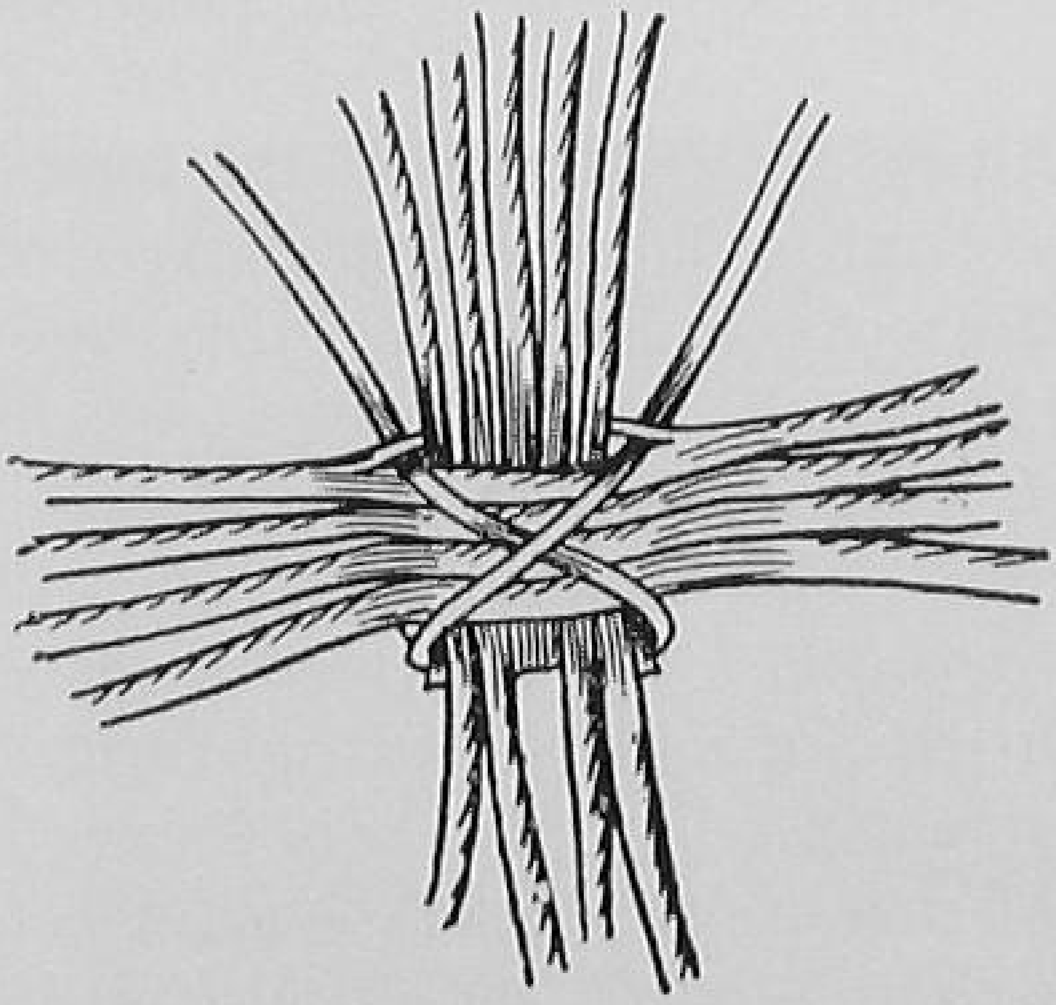


FIG. 83.

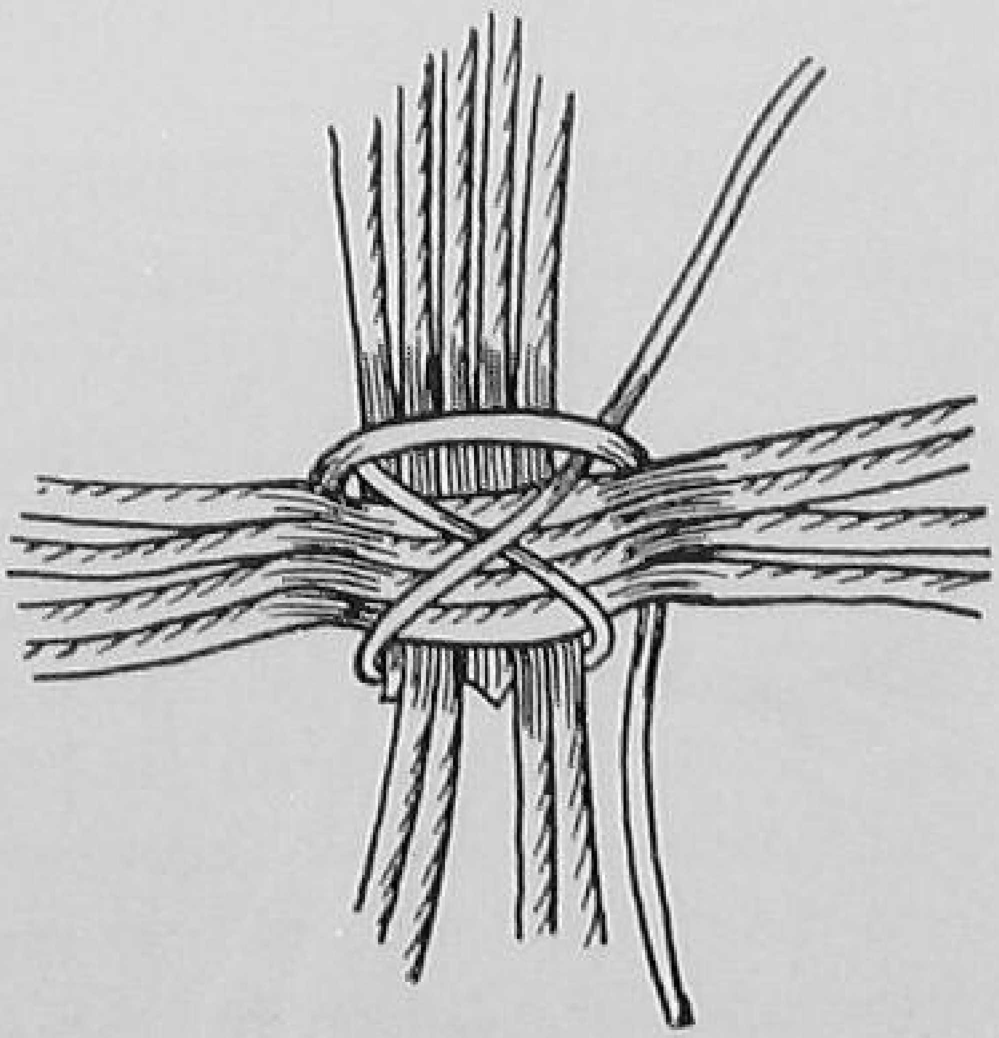


FIG. 84.

Chapter VII

CANE AND ITS USES

Cane is the name applied to a number of plants that possess long, willowy, reedlike stalks. There are about 300 known species. In a restricted sense the name applies to a class of palms, called rattans, of the genera *Calamus* and *Daemonorops*. These cane palms are climbing plants that trail along the ground, or climb trees in the jungle and swamps in tropical countries. They are to be found in China, India, Java, Sumatra, Sarawak, Ceylon, the Malay Peninsula, and the Indian Archipelago. The stems rarely exceed 1′ in diameter, but often grow from 100 to 300 feet in length. These plants are erect when small and remain so until they attain the height of several feet, after which the stem requires support. Support is obtained with the aid of a flagellum or feeler, which protrudes several feet from the tip of each leaf. These feelers are armed with hooked thorns that cling to the other vegetation. The outer bark of the rattan stalk is also covered with thorns and these extend along the underside of the leaf.

Since these thorns are sharp and strong, the gathering of the rattan stalks is very difficult. Native laborers can be interested in harvesting rattan palms only when there is no other work, such as rubber collecting, to keep them occupied. Cane palms are rarely cultivated, however, in the Straits Settlements, some attempts at cultivation have been made. To harvest the rattans, the natives wear thick leather gloves, as protection against the thorns, and cut the stalks at the base with a sharp axe. The branches remain hanging in the sun until the thorny surface is shriveled. In the drying process, the protective sheath is loosened from the rattan bark and removed by being drawn through a notch cut in the trunk of a convenient tree. The removal of this sheath reveals the hard, glossy surface or rind. It is this part of the cane stalk that is split into strands and used for chair-seat weaving.

The stalks are cut into lengths of from 12 to 30 feet, and bundled to be shipped to the sorting and grading depots. Singapore was formerly the chief cane material center.

After being graded, the selected rattan lengths are washed in a silicate solution. This washing brings out the beauty of the glossy surface to its greatest advantage. When the ridges found at the leaf-attachment locations have been smoothed down, the stalk is passed through a machine with rollers that press the cane against knives. The knives split and strip

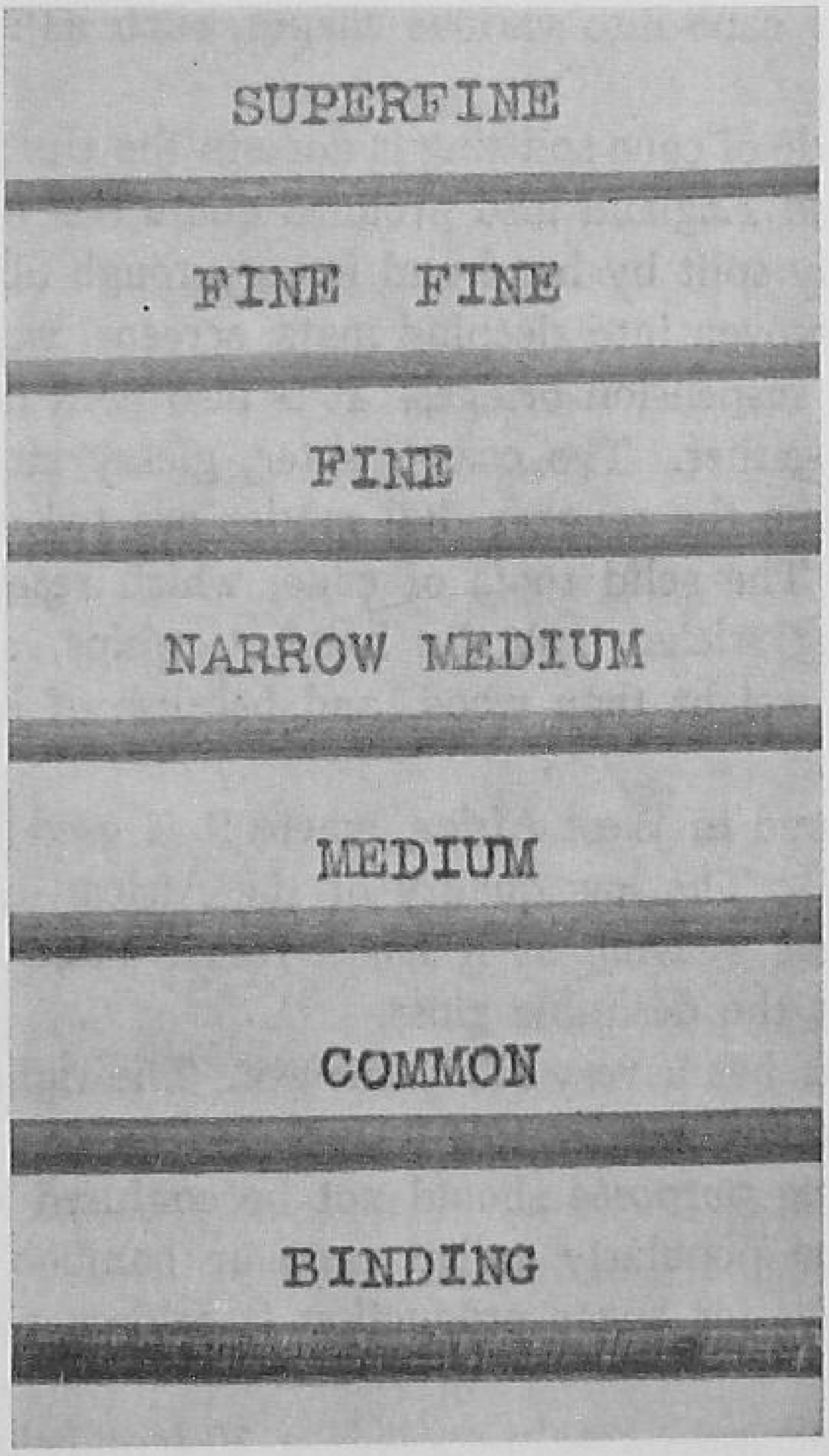


FIG. 85. Widths of cane.

the outer surface of the cane into fine narrow strips. The strips are planed on the sides and back, but remain slightly curved on the top. This glossy strand—the outside of the rattan—is the cane that is used for many types of caning, such as seats for dinette and bedroom chairs. Cane is produced in a number of widths (Fig. 85), known by the following names: Carriage, Superfine, Fine fine, Fine, Medium, Common, Narrow Binder, and Wide Binder. The order of naming is from the

finest to the coarsest. A hank of Binder contains about 500 feet, and the other widths are packed in hanks of approximately 1000 feet.

The remaining core of cane stalk is put through another machine and cut into reedlike strands. These machines have plates with sharp-edged holes, through which the cane is pulled and cut to the desired diameter. These strands range from $\frac{1}{16}$ to $\frac{5}{8}''$ in diameter. Other machines cut or split the center cane into various shapes, such as square, half-round, flat, or beveled.

The highest grade of cane splitting is done in the United States. France, Holland, Italy, and England also produce quantities of split cane. Chinese cane is mostly split by hand and is very rough and poor in quality. In China cane is woven into sleeping mats, screens, wall partitions, huts, fishing traps, and suspension bridges. It is also used by natives in tying teakwood rafts together. The coarse outer, glossy strands are used for jar wrappings, while the rougher dull grades are twisted into ropes and baling materials. The solid roots of cane, which resemble bamboo, are made into walking sticks, umbrella handles, whips, and mallets. This cane is lighter in weight than wood, and because of knotted grain does not split readily.

Cane is also found in West Africa, where it is used by the natives for rough basket work. The low quality of the African cane is very undesirable for fine seat weaving as it has a rough outer surface, is coarse-grained, and lacks the desirable gloss.

Cane from India has a very shiny surface. The right side of the cane strand is easily determined by this luster.

Cane for weaving purposes should not be confused with the domestic sugar cane, or the popularly called cane or bamboo of our Southern states. Cane grown for sugar production is seldom used for any other purpose.

Domestic bamboo cane rarely exceeds a 20-foot height. It is used in the fabrication of fishpoles, walking sticks, and bamboo furniture. Bamboo cane is grown as cane brakes in the deep South to take the place of fences in separating the fields of cotton.

The cane known to the trade as *Sarawak* is the best to use for hand weaving because of its good color and pliability. Its fine yellow, glossy surface is most desirable for furniture and basket making. The split outer layers of the rattan bark are used for chair-seat weaving and the rounded strands of the inner core are used for baskets, trays, and hampers. The rounded strands are called "pulp" cane, but they are far from being

pulpy. They are the center or core of the rattan stalk and very tough and fibrous. In a handwoven piece their fine glossy surface insures beauty combined with strength.

The *Palembang* cane, named after a port in Java, is darker in color and has a slightly ribbed surface. The coarser varieties are used for hampers and baskets. The finer grades, after being washed in a silicate bath, are used for chair seats.

A variety of cane called *Malacca* is not quite round and has a slight rib on one side. It is much stiffer than rattan, with larger leaf joints or notches. It is used almost exclusively for walking sticks.

Cane is supplied in bundles of from 14 to 20 feet in length. These bundles are bent in half for convenience in handling and as it is almost impossible to straighten out this bend it is advisable to cut the entire bundle at this point. This gives cane strands of a practical length to use.

Cane should be stored either flat, on a rack, or shelf, or the ends of the lengths tied together loosely, making a broad loop. This loop of cane can then be hung up in some convenient place. Cane should never be stored coiled up or near steam pipes, as it will become very brittle and crack easily. If the cane has been coiled for ease in shipping, the coil must be opened, the cane soaked in water, and one end of the cane length fastened to a high support. As the cane dries in this position, its weight will cause the strands to straighten out.

Materials for Cane Weaving

The following guide may be used to determine the size of cane required:

Size of Hole	*Space Between Holes*	*Size of Cane*
3/16″	3/8″	Superfine
3/16″	1/2″	Fine fine
3/16″	5/8″	Fine
1/4″	3/4″	Medium
5/16″	7/8″	Common

Tools for Cane Weaving

The tools needed in cane weaving are few in number. A special one is called the caning needle, but it is not very practical and not very extensively used by experienced caners. These may be made, very often, in the school shops. A buttonhook with the hook flattened and an eye cut in the blunted point serves admirably. The other tools needed are a

scratch awl and a pair of scissors or knife. A pair of dividers, a rule, and a center punch and mallet are necessary for marking the location of the holes. A brace and 3/16″ bit may be needed if the holes for the cane need to be drilled. Several wood pegs are useful. They are made from a 1/4″ dowel rod or the equivalent, and should be 4″ long. Four pegs are usually sufficient. The amateur, however, is inclined to use a greater number. The pegs should be tapered at one end, similar to the point of a lead pencil, as shown in Fig. 91.

General Instructions for Caning

There are two distinct types of cane seat with much the same appearance when completed. The one more often used in handcraft shops is known as "hand woven." It is made by weaving strands of cane through holes in the seat frame to form the desired pattern. The second is called a "pressed seat," because the cane, woven in the desired pattern by machine, is wedged into a groove in the seat frame, held in place by glue, and covered with a piece of shaped reed called "spline."

Hand-woven caning is a specialization of the weaving process, which, in proper correlation with wood in the school shops, promotes an appreciation of constructive design in which the element of beauty is a prime consideration.

Caning is not difficult. It, in common with many other lines of craft activity, is best learned through observation, practice, and more practice. It is a practical medium in which utility of design has definite commercial value ranging from that of a hobby craft to that of a thriving business.

One of the main points to remember in cane weaving is that the cane should never be worked dry, for in doing so its capabilities and qualities are sacrificed. It is not necessary, however, to keep it soaking for any great length of time. It is sufficient to pass it through water, but after it is removed it should be allowed to drain a few minutes before it is used. As it becomes dry during the weaving it may be dampened with a wet sponge or brush.

In weaving the interlocking strands, such as steps four, five, and six, do not attempt to weave too far at one time without pulling the cane strands through and making them taut.

All lines of caning should be kept as nearly straight and parallel as possible.

All holes are used in square and rectangular shaped seats, but this is not always true in seats of unusual shapes. But on square and rectangular

shaped seats the corner holes are used only with the diagonals. In each case the corner hole is used as a terminal for two parallel diagonals.

It is not advisable for the beginner in caning to have his initial experience on a chair seat, for the area to be caned is usually of an odd shape. Many times the arms, legs, and back upright may interfere. Therefore for the first trial use any square or rectangular frame that has no projecting sections.

Preparation of Frame

If the available frame does not have the holes already drilled it should be prepared for the weaving process in the following manner.

Draw a line around the frame ½″ from the inner edge. This distance remains constant, usually, on all areas, and with canes of various widths. With a pair of dividers set at ½″, space off points on the line, starting at a corner where the lines intersect.

It is essential that spacing be done in the same direction on parallel rails, for on some frames the last space may be shorter than ½″. In such cases it is necessary to divide the last several spaces into divisions as near ½″ as possible.

The beauty of caning is enhanced if the caning strands run as nearly as possible in straight lines; so it becomes apparent that the corresponding holes on opposite rails must be in alignment.

Use a 3⁄16″ wood bit to bore holes through the frame. It is advisable to countersink the holes on the underside as an aid in inserting the strand of cane.

If the center of each hole is marked with a center punch, the bit will then start more accurately, and the danger of getting the holes out of alignment will be reduced to a minimum. Remove the pencil line and rough edges with sandpaper.

The frame may be clamped to a table or work bench, but this necessitates reclamping at each change of direction in caning.

Chapter VIII

PROJECTS IN CANE WEAVING

Hand Seat Weaving or Seven Step Caning

Materials

A square or rectangular seat frame
Cane—size determined by space between holes and size of hole in frame. 12″ x 12″ seat frame requires approximately 100′ of cane
Binder—50″ for 12″ x 12″ seat frame
Shellac
Varnish
Wax

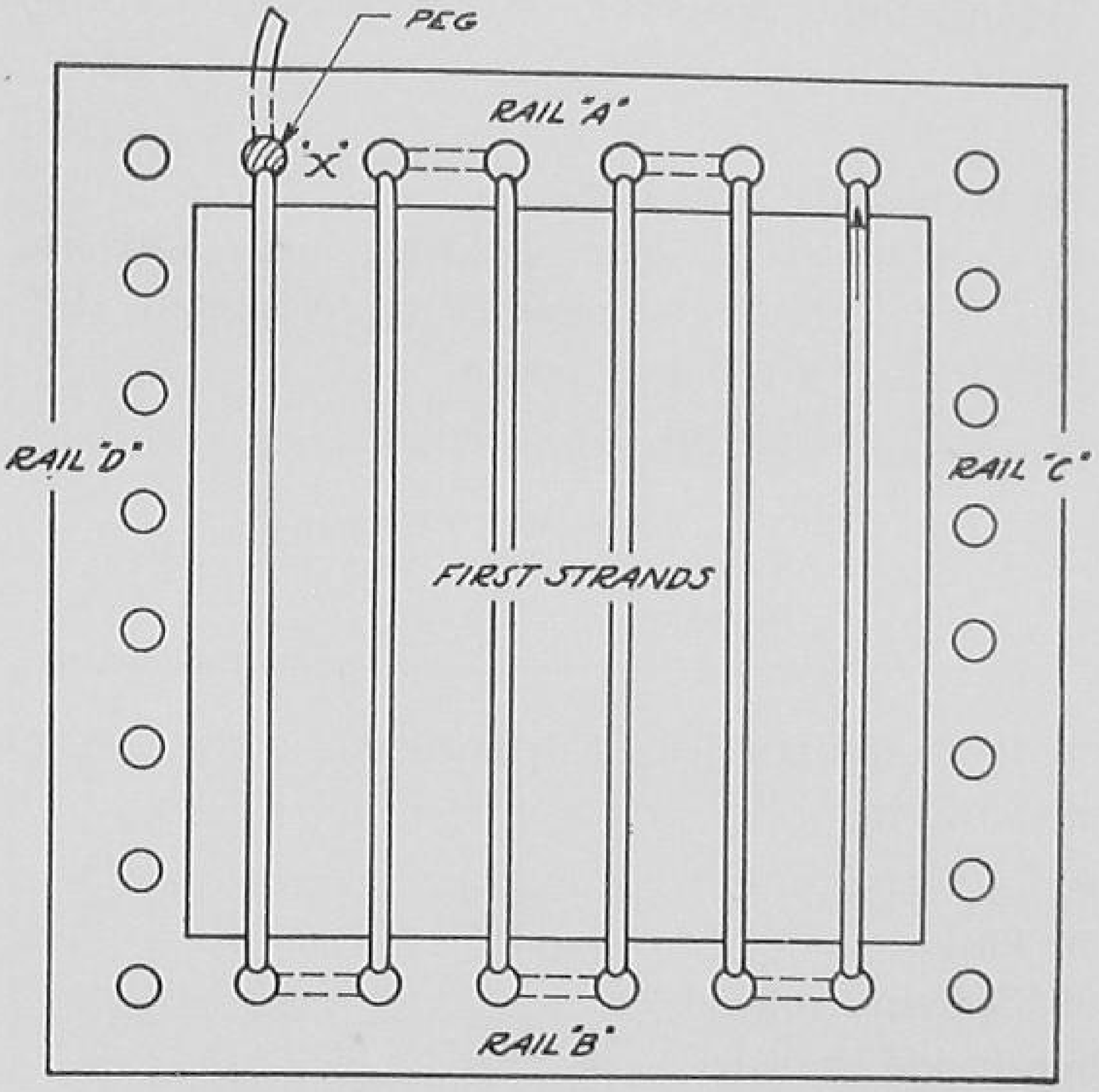
Tools

Caning needle if desired (length determined by the nature of the work being undertaken)
Scratch awl
Scissors or knife
Pair of dividers and rule
Center punch and mallet
Several 4″ pointed ¼″ dowel pegs
Sponge or small hand brush
Brace and 3/16″ bit—needed

Procedure

Step 1. Soak a hank of cane 10 to 15 minutes in cold water or a shorter period in warm water. Do not soak it too long, as it needs to be pliable, but not stringy. If it becomes dry while you are working, you may use a damp sponge to moisten it. While the hank of cane is soaking, letter the rails of the seat frame with "A" at the back, 'B" at the front, "C" at the right, and "D" at the left. Start a strand by drawing one end through a hole next to a corner hole, as shown at position *X*, on rail "A"

in Fig. 86, and let it project about 3″ below. Fasten with a peg. Starting at the peg, pull the entire strand through the thumb and the forefinger to prevent twisting, and pull the end down through the hole on the opposite parallel rail, rail "B," next to the corner hole. Bring the end up through the adjacent hole on the same rail taking care that the cane is not twisted on the under side of the frame but lies as flat as it does on the top. Pull the cane reasonably taut, and fasten with a peg, to prevent the



STEP I

FIG. 86.

strand from slipping back and becoming loose (see Fig. 87). Draw the cane through the thumb and forefinger again. Pull it across the frame and down through the hole next to the peg and up through the adjacent one. Pull taut and fasten with another peg. Repeat this operation until all holes have been utilized on the two parallel rails "A" and "B," except those on the corners. In all seven operations continue to draw the cane between the thumb and the forefinger to prevent twisting.

Step 2. In this step the caning strands run from right to left on rails "C" and "D" (Fig. 88). This operation is similar to Step 1, except that

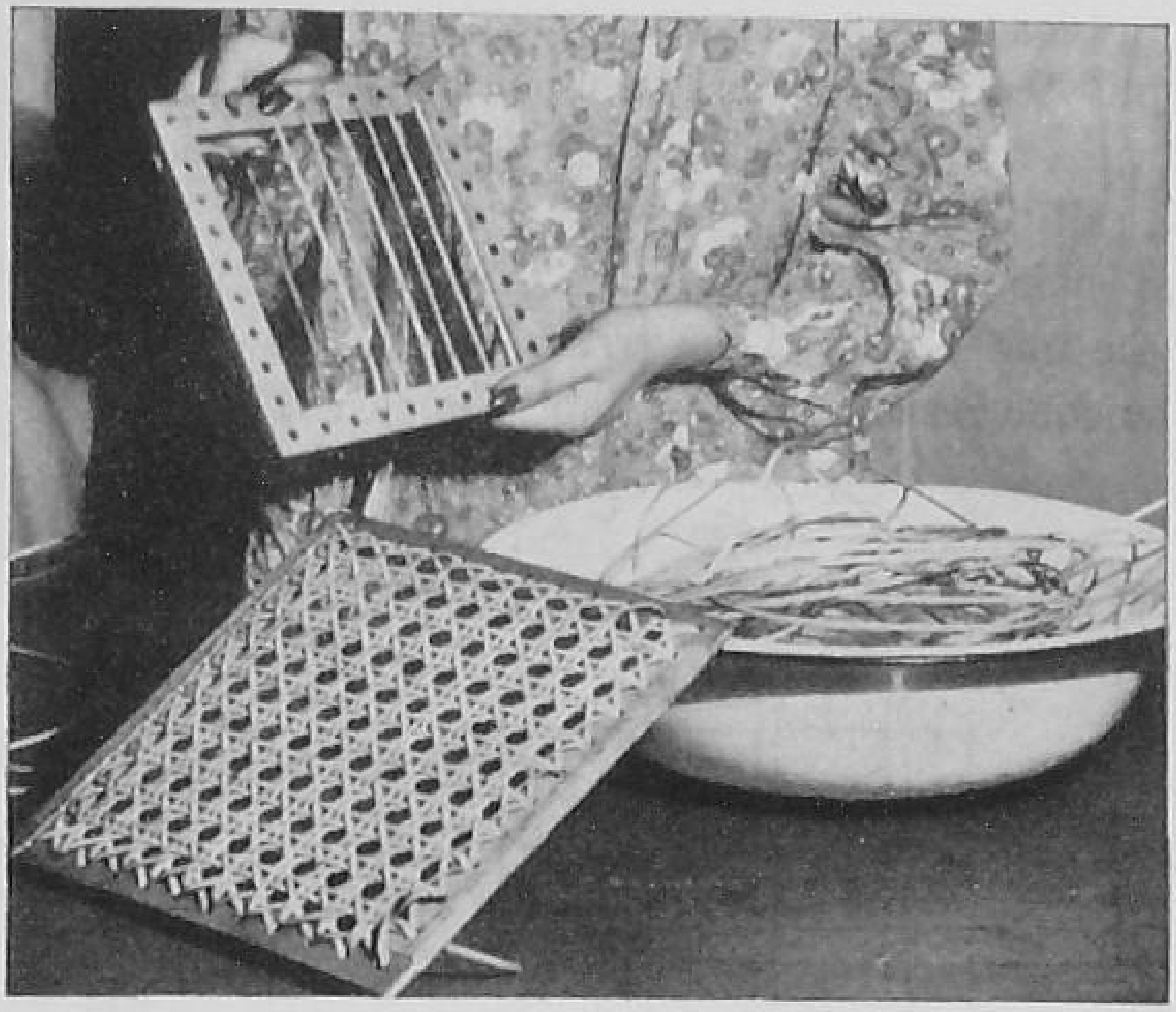
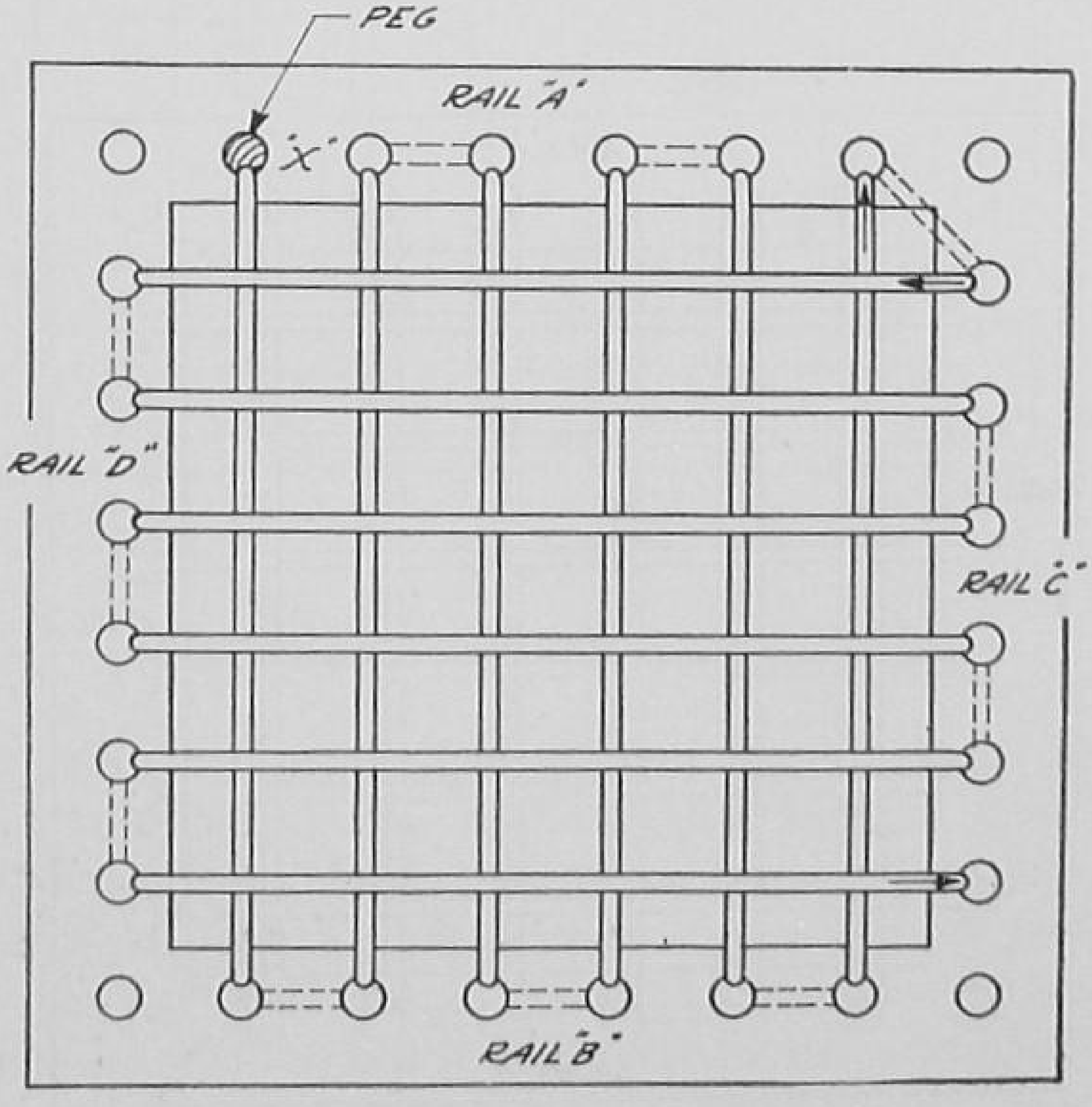


FIG. 87. Fasten cane with a peg.



STEP 2

FIG. 88.

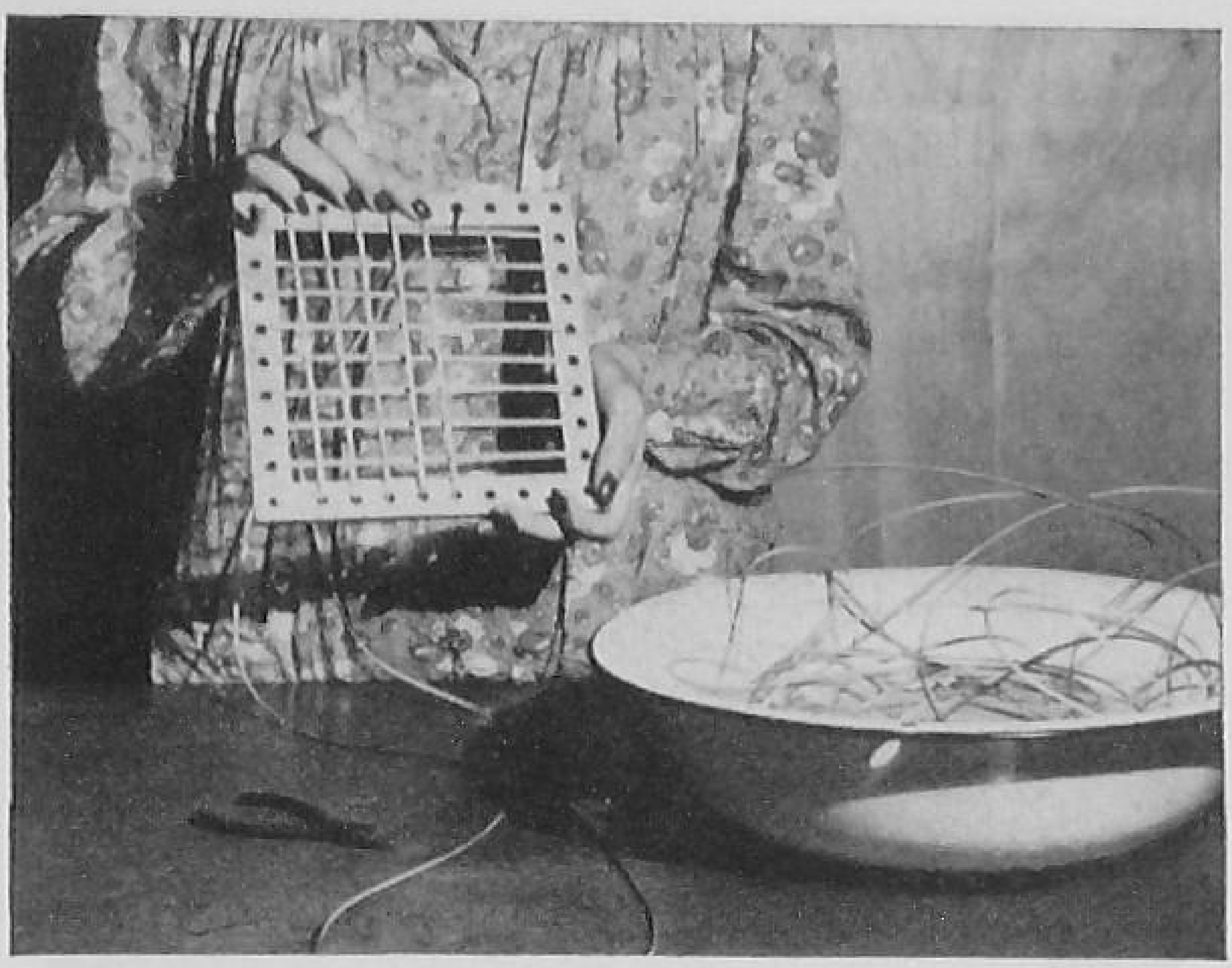
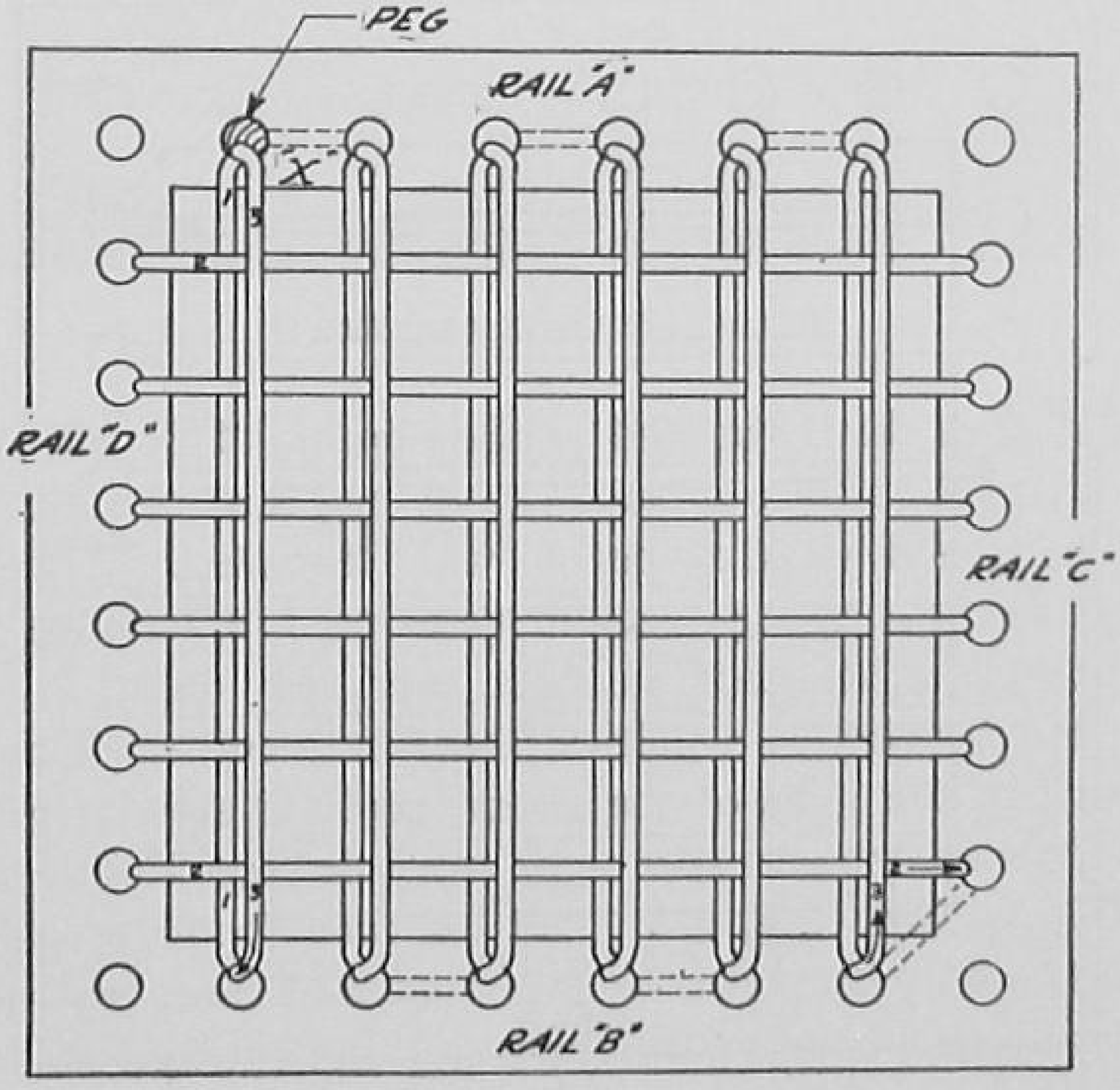


FIG. 89. The canes crosses over the first set of parallel canes.



STEP 3

FIG. 90.

the other two rails are used, and the canes cross over the first set of parallel canes (see Fig. 89). If the first strand of the cane has not been fully used in the first step, the remainder may be used to begin the second step.

Step. 3. The canes in Step 3 run parallel with those in Step 1 and cross at right angles the series made in Step 2 (Fig. 90). The strands run from rails "B" to "A." As each strand is used up, bind the end underneath the frame by pulling it under a cane strand, over and around the same strand. Then cut off the end about ¼″ from the row of holes. The tab end at the starting point is secured in this manner (Fig. 91), and

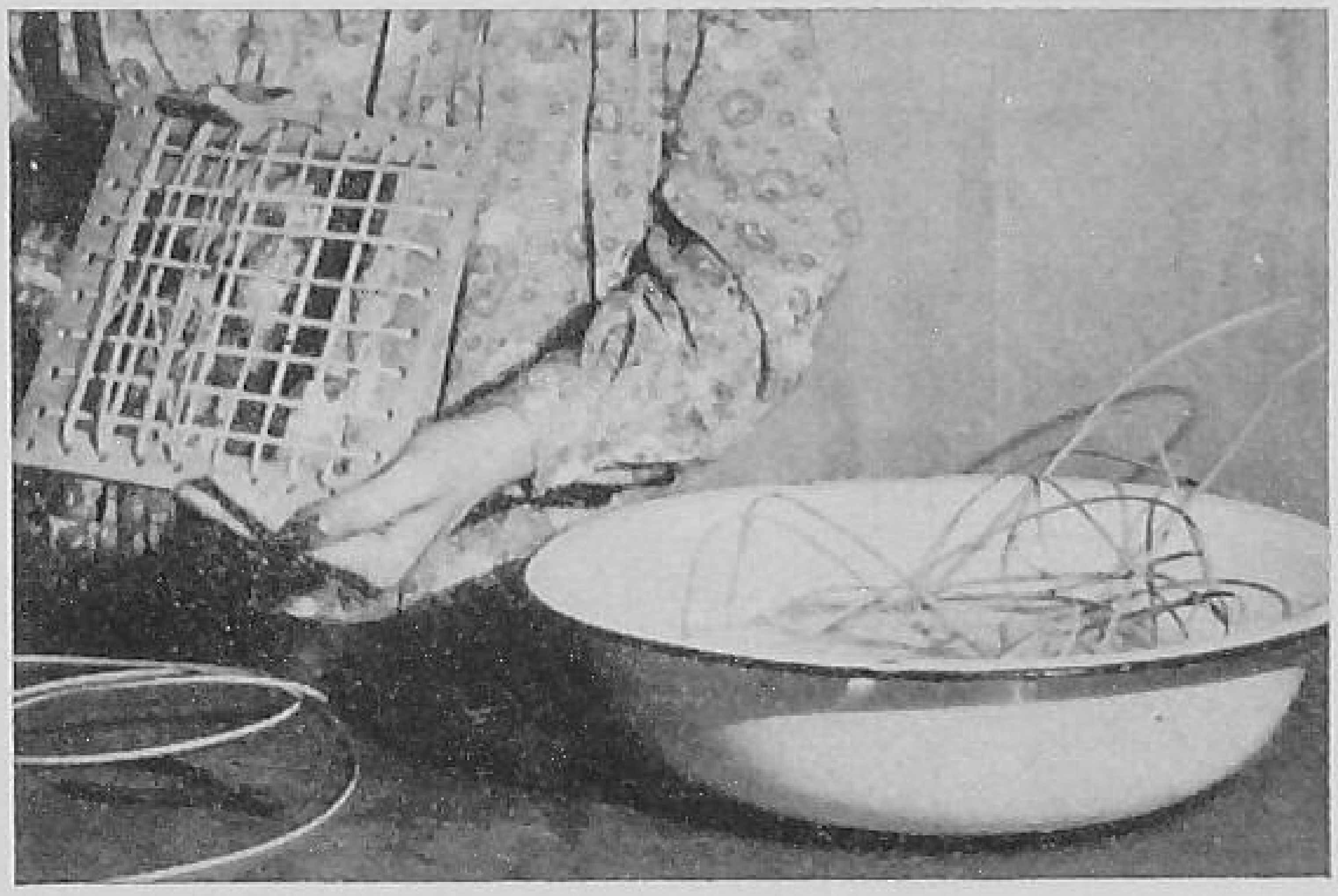


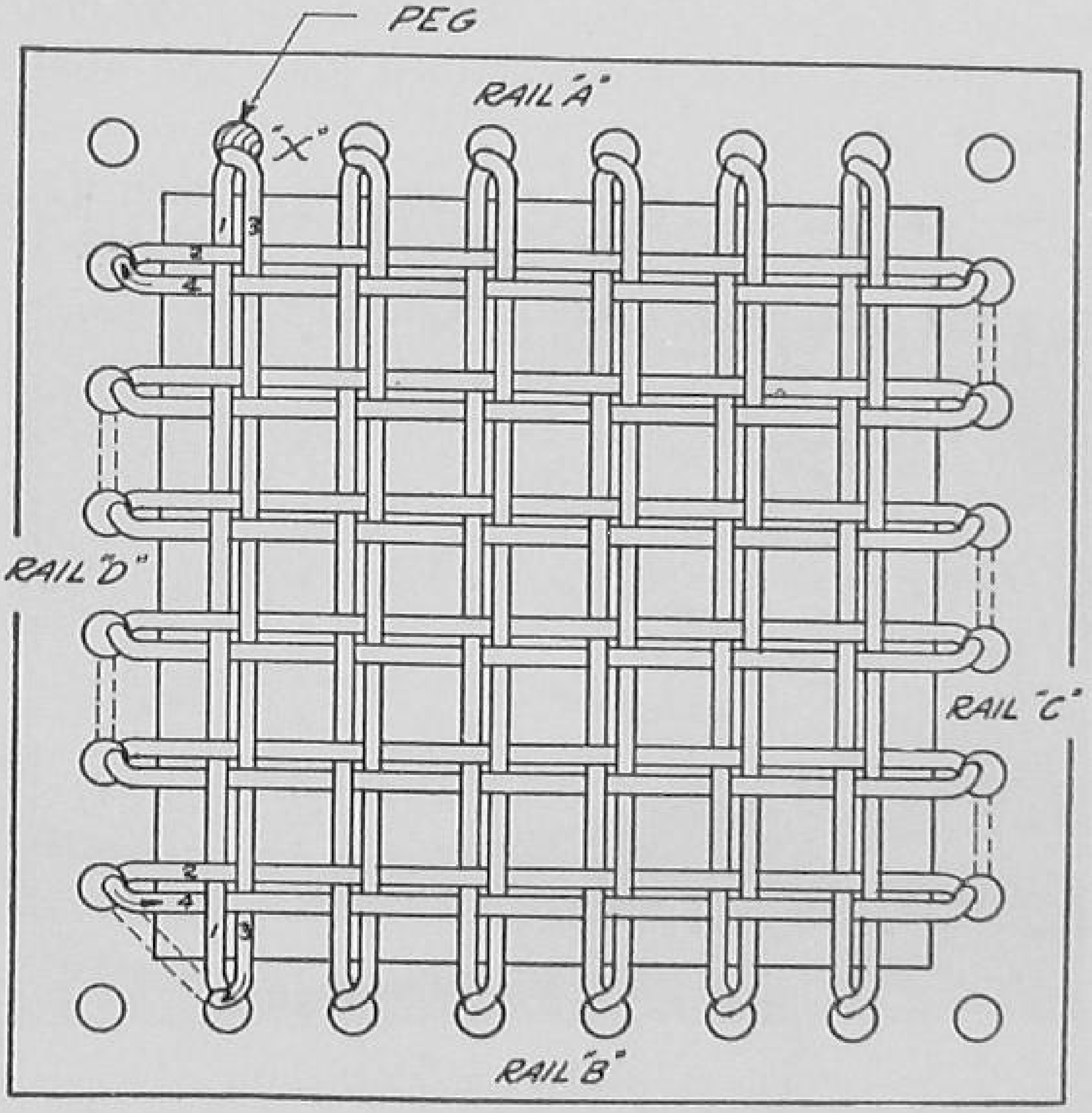
Fig. 91. Fasten the tab end.

all subsequent ones should be tied as they occur. This will prevent any interference that too many pegs might cause and insures a neater binding.

Step 4. The actual weaving begins with this step. It may be done entirely by hand, or a caning needle may be used. Carry the cane to the right side, through a hole that has been used only once, on rail "D" or "C." Begin the weaving at a hole adjacent to a corner. Carry the cane parallel to and to the right of the strand made in step 2; go *under* the strand made in step one and *over* those made in step 3 until the opposite parallel rail is reached (Fig. 92). Pull the cane down through the same hole as used in step 2, thus pairing two strands of cane. Pull the cane up through the adjacent hole on the same rail and proceed to the opposite rail, going *under* strands of Step 1 and *over* strands of step 3.

If a caning needle is used it must be inserted from the opposite rail of the frame from the cane strands in order to catch the strands behind the

point in going under and over the strands necessary to form the weave. Note that the point of the needle must be turned from side to side. After the needle has been worked under and over the correct strands the end of the cane is threaded in the needle eye and pulled through. Woven squares are alike in pattern regardless of how the frame is turned.



STEP 4

FIG. 92.

On a practice frame in order to facilitate the weaving process the frame may be swung so that the position of the front rail "A" and the back rail "B" is interchanged. In this case the second interwoven strand will run parallel to and to the left of the strand made in step 2. Swinging the frame back so that rail "A" is at the front again will require the third interwoven strand to duplicate the first strand in going to the right of its pairing strand (Fig. 93). The fourth strand will duplicate the second by going to the left of its pairing strand. This alternating continues until all strands of step 2 have been paired.

On a chair where the back upright would prohibit the swinging of the work, this second interweaving strand would have to be worked from

back to front, which would require the strand to run parallel and to the right of the strand made in step 2. This procedure must be repeated each time a strand is paired regardless of whether it runs toward the back or front rail. Be careful that a twist does not occur in the cane strand. Pull the cane down through the hole, pairing the canes. Pull the cane up through the next hole; then start the needle from the opposite rail of the frame and repeat the first operation, thus pairing another set of canes. Continue until all canes are paired and all holes are used, except the

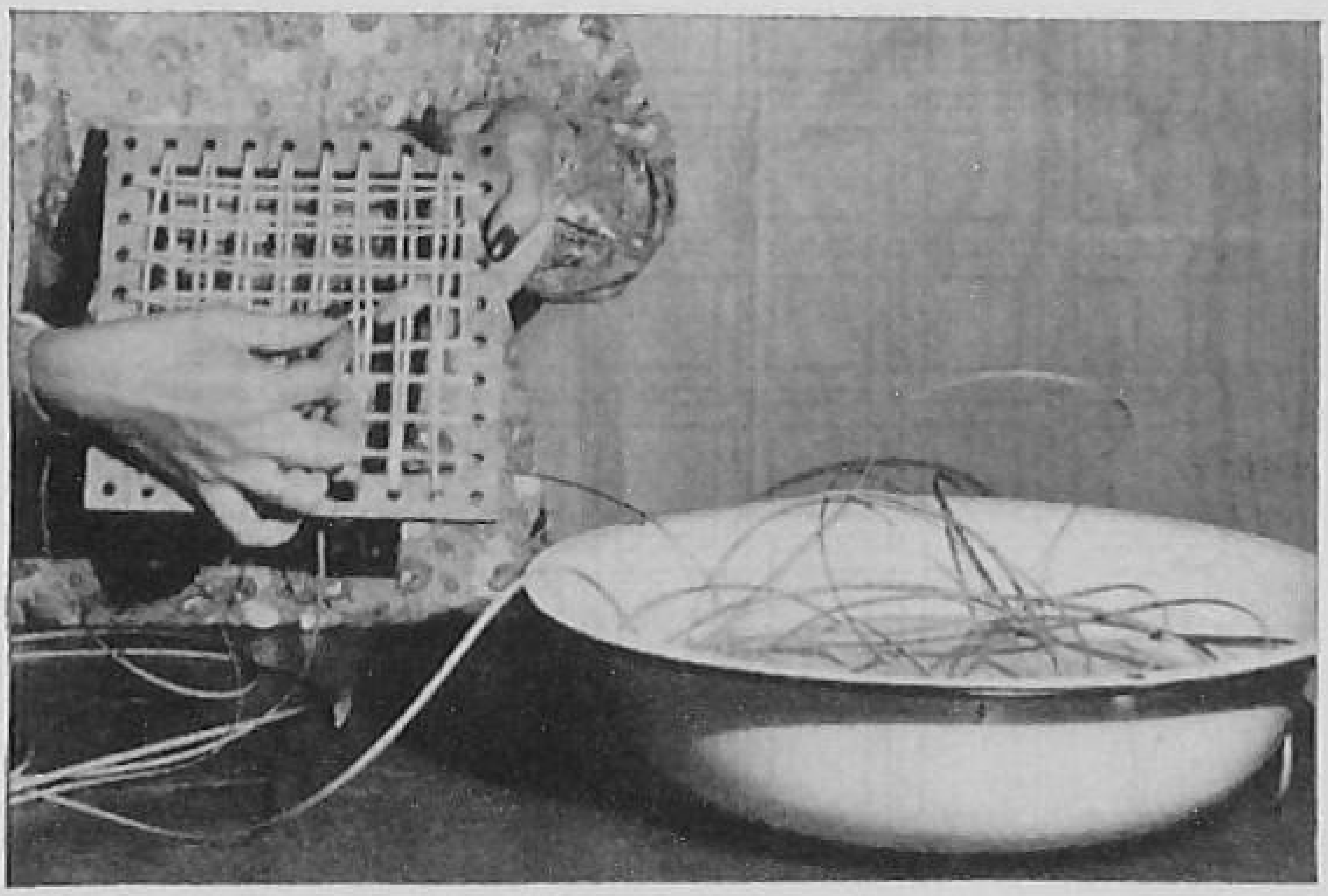
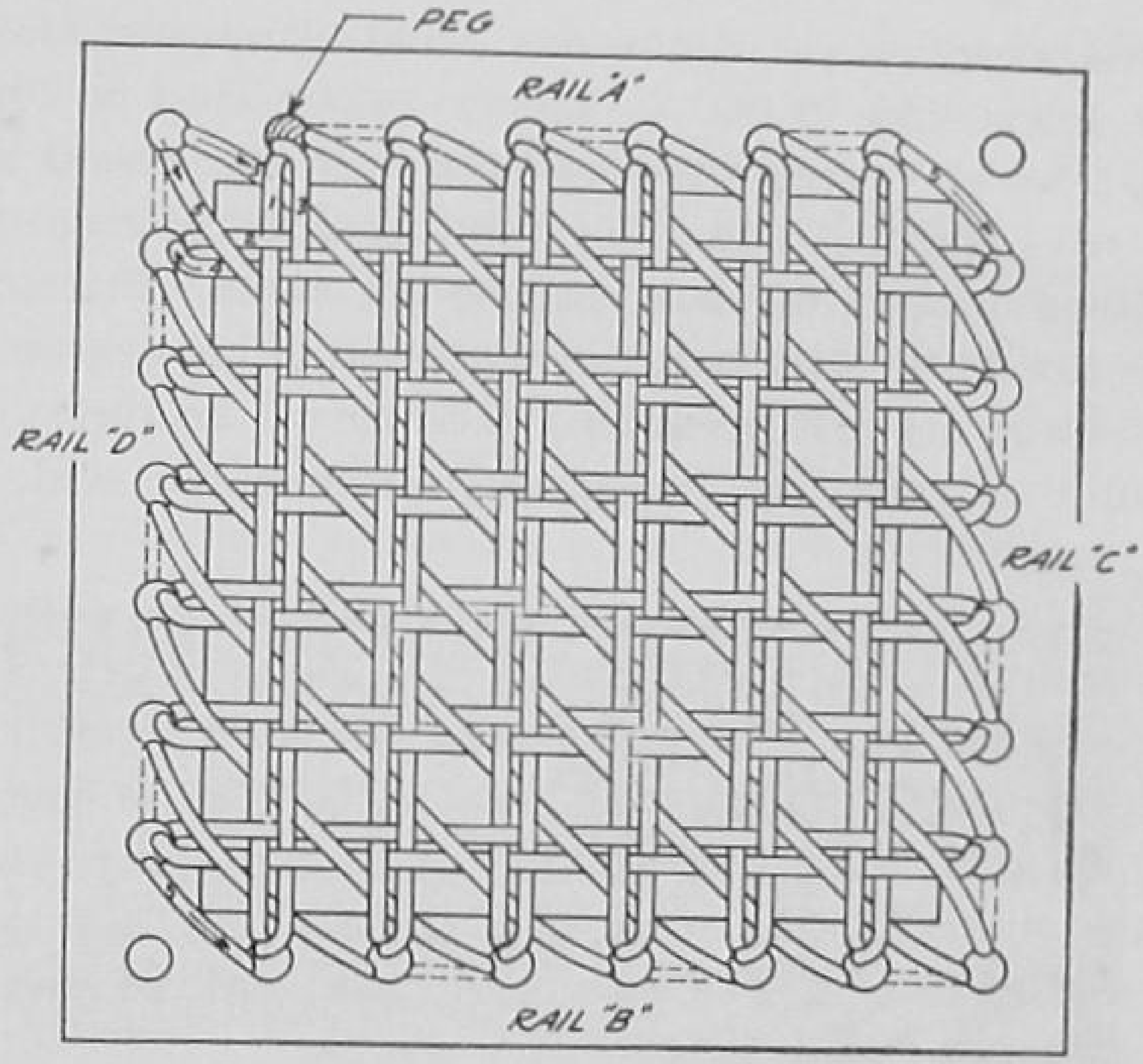


FIG. 93. Pairing strands.

corner ones. Soak the woven cane with a wet sponge and with a wooden peg straighten the strands of cane and force all pairs together. In this way, small open squares are formed over the area being caned. Unless cane is soaked it may prove difficult to pair canes.

As weaving progresses, difficulty will be encountered in inserting cane ends in the holes, because the holes become filled. Force the scratch awl through the hole and turn it several times. This will force the strands already in the hole closer together and allow additional strands to be inserted. In many instances long ends of cane remain from one step to another. These should be used up in succeeding steps, with one exception: they should be used provided it is not necessary to carry them over more than two holes on the underside of the frame. The fewer loose ends left, the better, for the caning is thereby neater and stronger. It is advisable to work with a full length of cane, wherever possible, to avoid an excessive number of these loose ends.



STEP 5

FIG. 94.

Step 5. First Diagonal. The first diagonal canings go *under* the double verticals (front to back strands) running from rails "A" to "B," and *over* the double horizontals (side to side strands), running from rails "C" to "D" (Fig. 94). This step is the weaving of one set of diagonals.

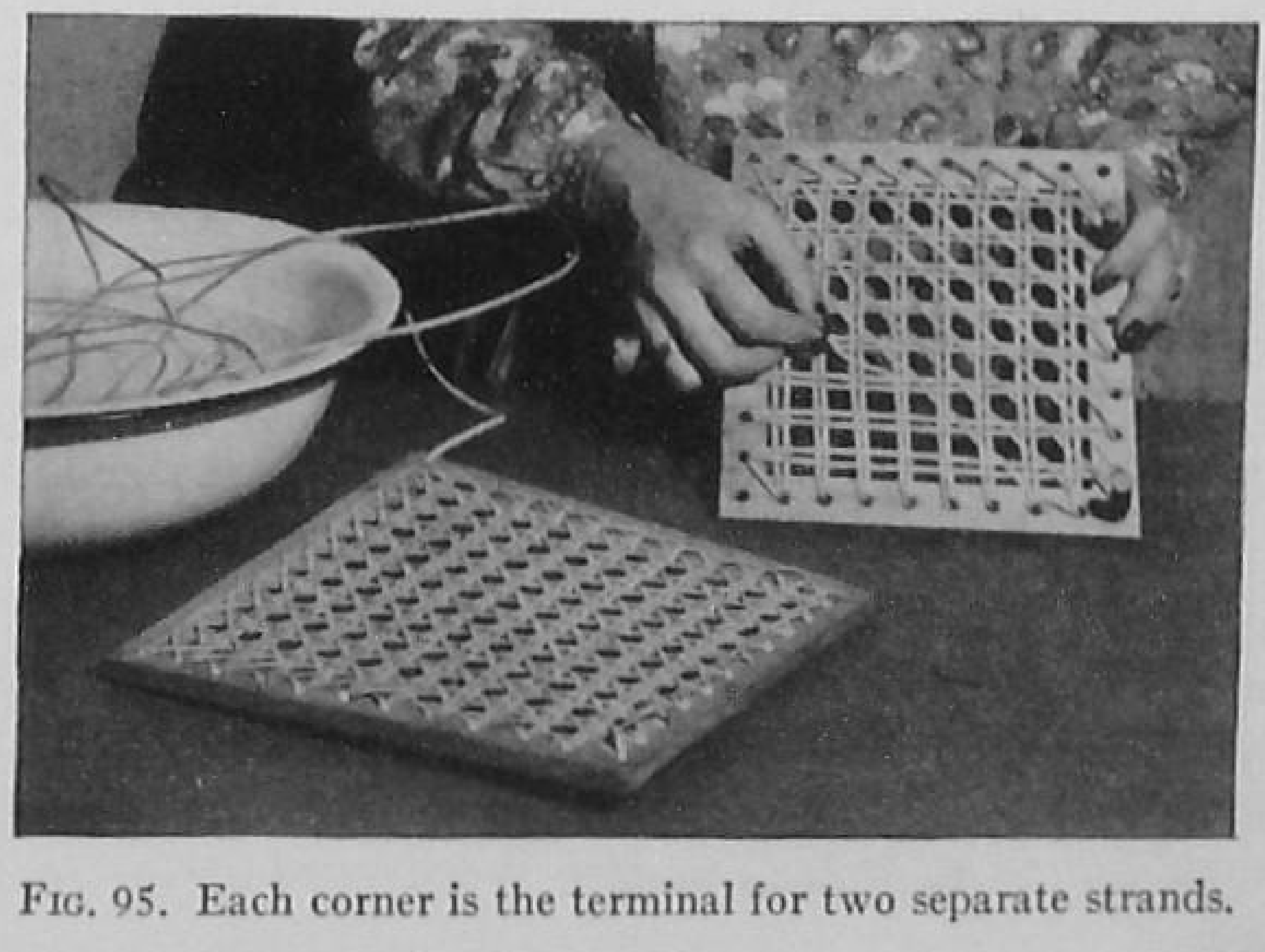


FIG. 95. Each corner is the terminal for two separate strands.

On a square frame start the strand at the left rear corner and carry the cane to the right front corner as follows: *under* steps 1 and 3 which are parallels between rails "A" and "B" and *over* steps 2 and 4 which are parallels between rails "C" and "D." Weaving diagonally across a square seat from one corner to another is somewhat easier than starting at a corner. In weaving the diagonals the canes run either over or under the pairs at the corners, the same as in the center of the frame. Also each corner hole is the terminal for two separate strands (Fig. 95).

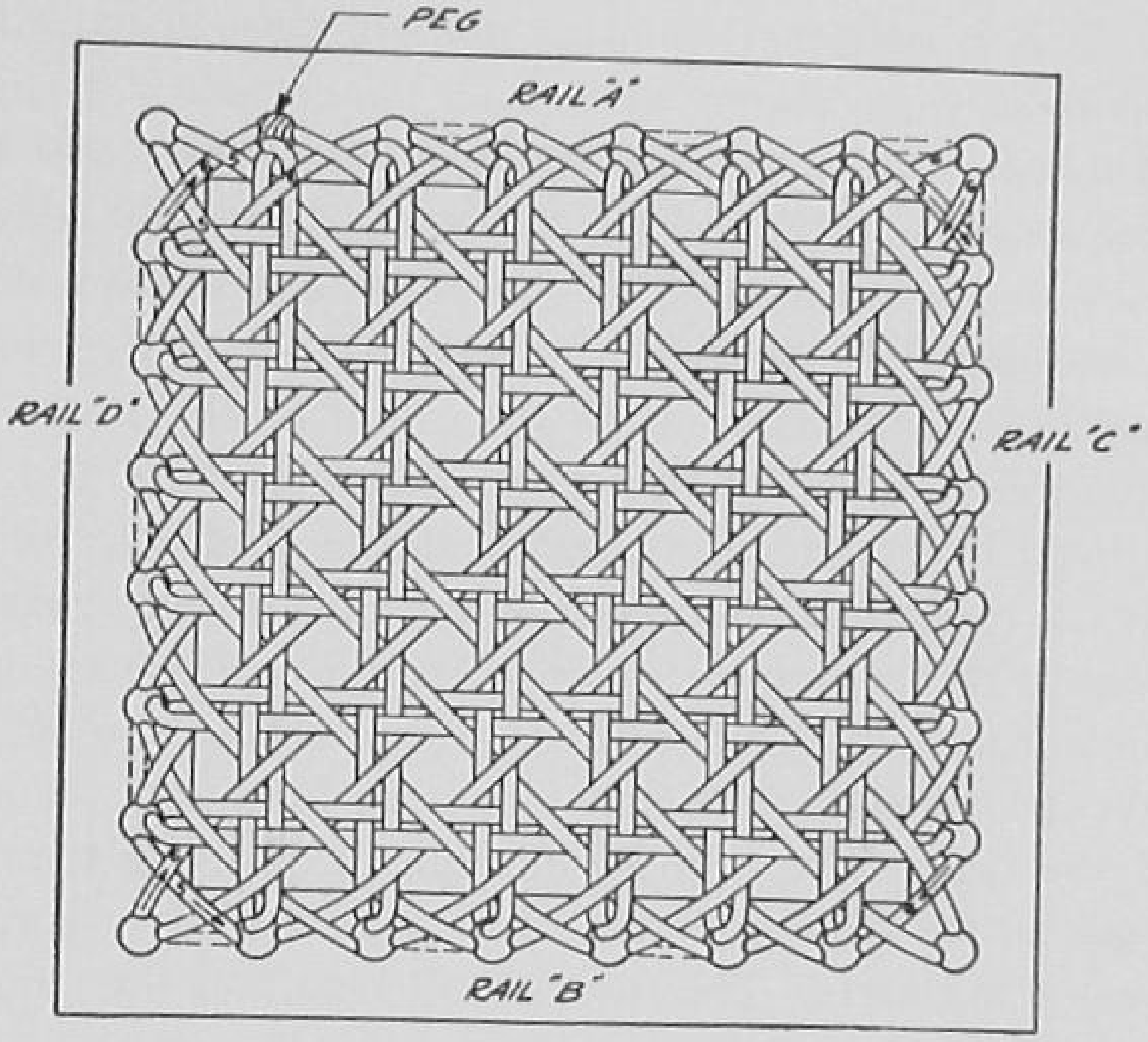
Use one hand over and one under the frame. As your skill increases you may find it easier to give the end of the cane a slight curve and work with both hands on the upper surface. Use a length of cane long enough for convenient handling. Then pull the entire strand through the length of the frame, provided the diagonal is not so long as to cause excessive twisting of the cane. The cane strand can be run easily, and partially under a cane strand at the corner of a square, if it is correctly done. Fig. 95 shows this clearly. The corners will bind and the strand will pull with difficulty if the cane is incorrectly woven.

After weaving the first center diagonal, complete the remainder of the diagonals on that half. Then start a new strand to weave the second center diagonal and complete the remainder of the diagonals on that half.

On a *rectangular* frame great care must be taken in weaving the first diagonal to have it terminate in the proper hole on the adjacent rail. It could not possibly end in a corner hole, for then the caning strand would not be a true diagonal.

The beginner will find his greatest difficulty in properly weaving the diagonals at the edges, that is, immediately upon entering or leaving a rail hole. Be careful to have the cane go over and under the proper strands at these points. Many fine projects of caning are lessened in value by improperly woven edges. The ends on the underside of the frame may be fastened neatly and securely by a half-hitch: pass the end under the nearest strand on the underside of the seat (without crossing any holes), over and under the same strand again, and cut it off, leaving about ¼ inch end. Passing over a hole on the underside should be avoided if possible, as this does not look well and will interfere with the use of that hole.

Step 6. Second Diagonals. Using the strand remaining from step 5 weave the second diagonals by going over the front-to-back strands between rails "A" and "B," and under the side-to-side strands between rails "C" and "D" (Fig. 96). This step is the same as the preceding one



STEP 6

FIG. 96.

except that the diagonal caning goes over step 1 and 3 and under step 2 and 4, and runs in the opposite direction to step 5, thereby forming right angles to the first diagonals. In this step two strands also run into the corner holes (Fig. 97). This holds true in all rectangular frames where a corner hole is bored. It permits the strands to run in as straight a line

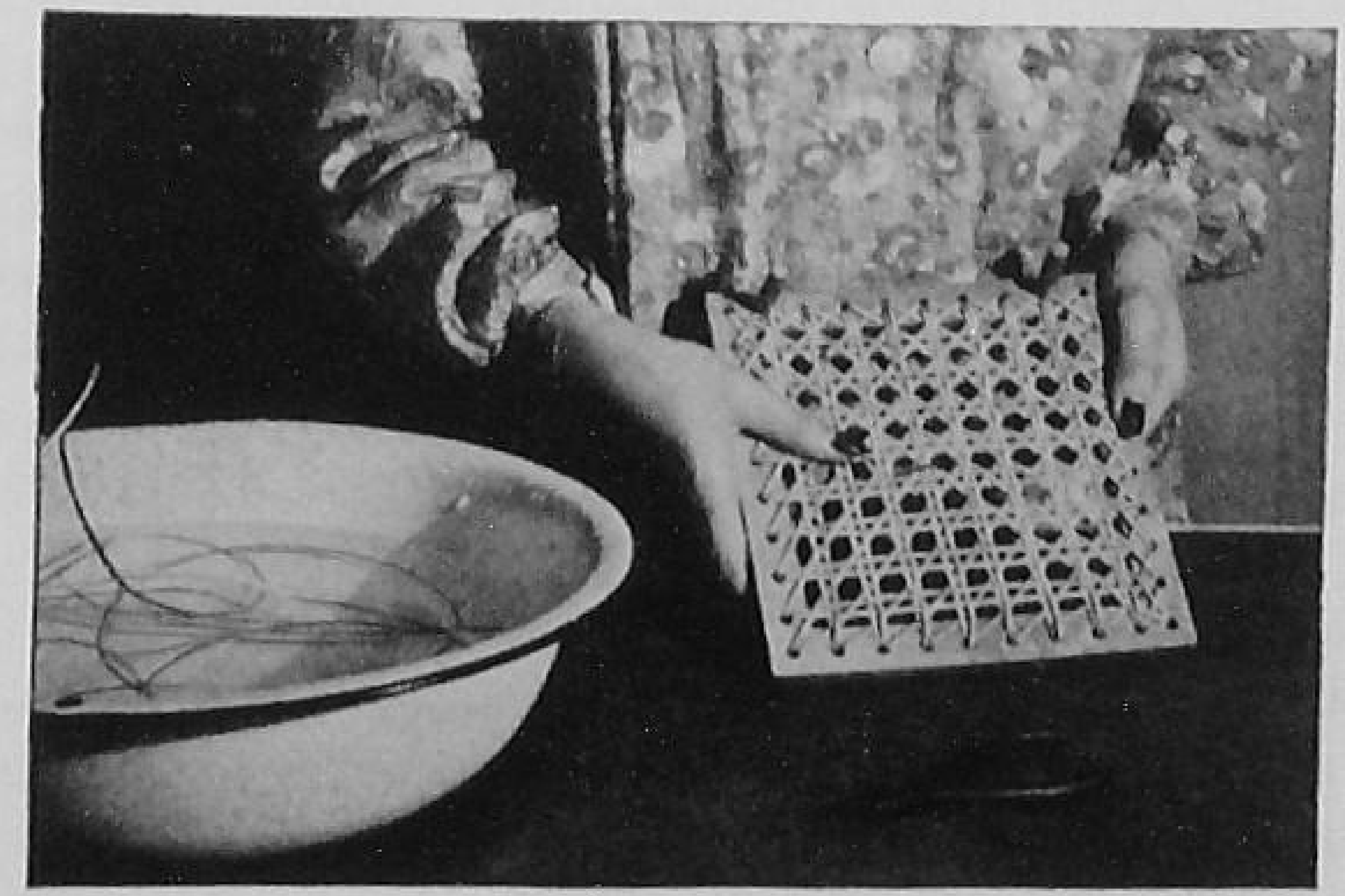
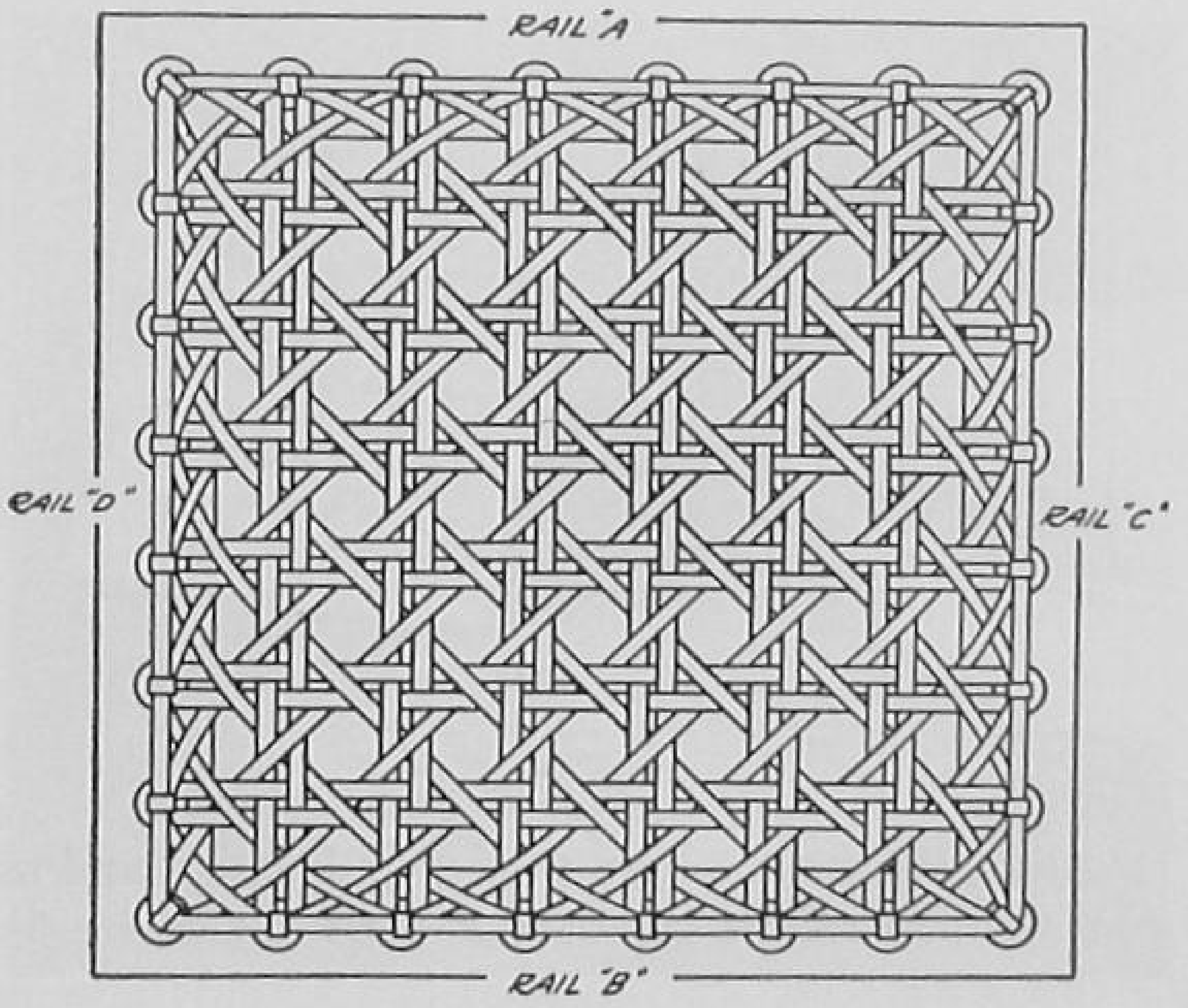


FIG. 97. Second diagonals, step 6.

as possible. If it is necessary to make a sharp turn to enter a hole it is obvious that an error has been made.

Step 7. On some caned articles the addition of a binder is a matter of taste, as the series of spaced holes is pleasingly regular. But on chair seats a binder is essential to protect the ends of the canes, for they are subject to hard wear (Fig. 98). On seats having square corners short



STEP 7

Fig. 98.

pieces of binder may be used, or a piece of binder long enough to go around the seat plus 1″ for splicing. To tie the binder use a strand of cane of the same size as that used in weaving the seat. Start at any corner and peg the end of the binder in the hole adjacent to the corner. Insert in the third hole from the starting point the cane strand to be used for tying down the binder and carry the cane strand over the binder and back down through the same hole. The cane strand forms a loop and when this loop is pulled down flat it secures the binder. Pull the strand taut, then insert it in the next hole, pull it up over the binder and down again, and so on (Fig. 99). When the holes are close together this operation may be repeated at every other hole.

Continue all around the seat, keeping the binder flat and tying the

strand taut. When the first end of the binder is reached lap the last end of the binder over it and secure it by covering both ends with the final loop. Then cut off the top strand of the binder close to the final loop. If the binder strand is very thick it may be necessary to skive (reduce the thickness of the strand) before lapping it over.

At times, when the last strands are woven, it may prove advisable to

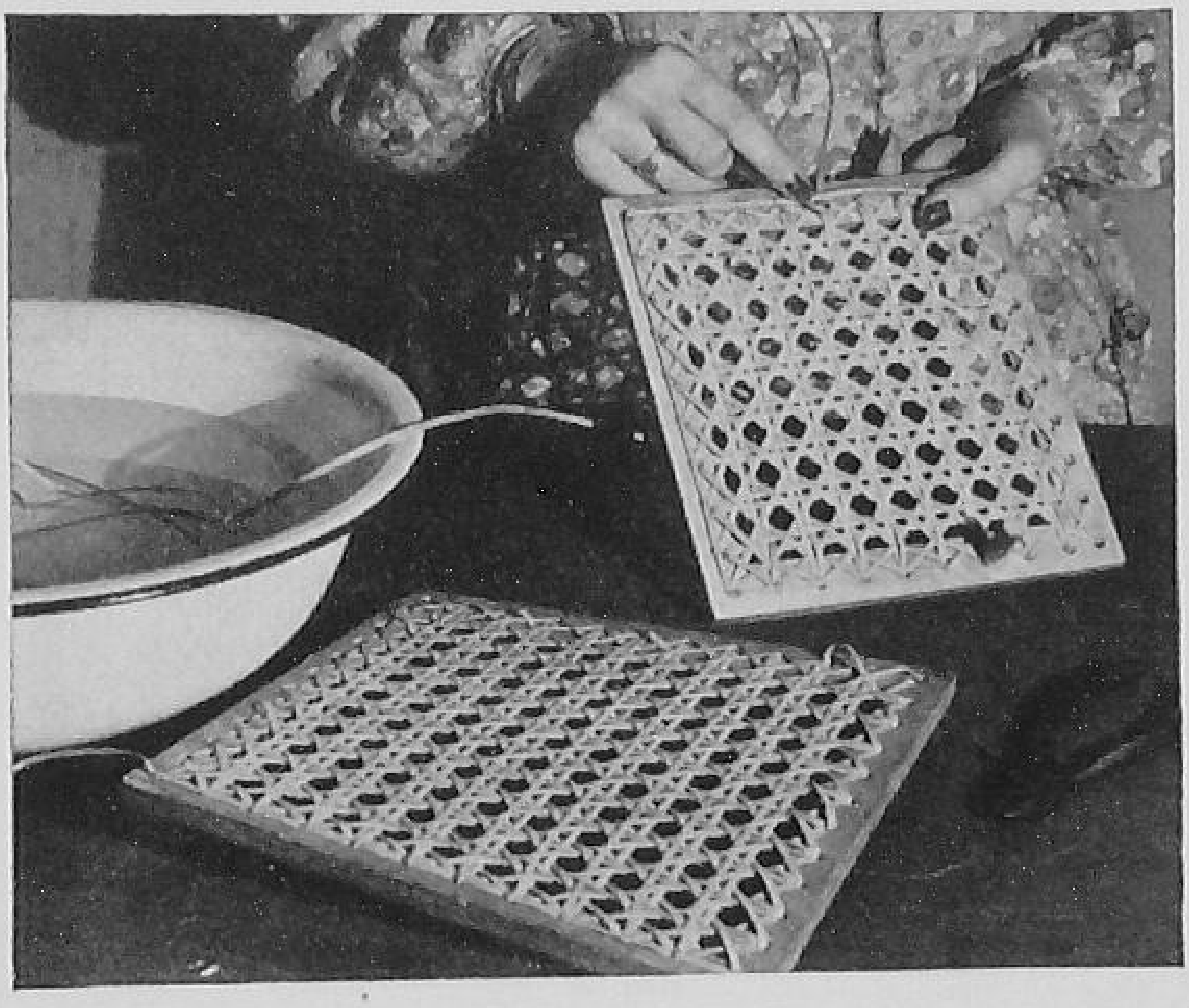


FIG. 99 . Binding.

secure the cane underneath the frame by plugging the necessary holes. This should be done in instances where the canes may have a tendency to work loose. Drive pegs of soft wood into the holes and cut them off even with the top of the seat. Be careful not to mar the surface of the chair in cutting off these pegs. If a knife is used to score a deep cutting line on the peg, a tap with a mallet is all that is necessary to complete the breaking off. Any roughness may be smoothed down with a knife or sandpaper.

Finishing. Cane may be given a coat of shellac or varnish, or left natural, as desired. It has a natural hard, glossy finish and it is not necessary to use any preservative coating to retain this finish. However, if a matching stain is desired, water, acid, or alcohol stains may be used. Oil base stains do not make appreciable changes in the color of cane. An antique-finish effect can be obtained by applying a coat of varnish and partially rubbing it off just as the varnish becomes tacky.

Irregular Shaped Caned Chair

On irregular shaped areas to be caned the principles of weaving remain the same, but each area requires slightly varied treatment. It is often necessary to skip some holes in various steps altogether in order that the parallel strands be kept absolutely equidistant and the diagonals straight (Fig. 100). In weaving the diagonals it is frequently necessary to run several strands in one hole in order to keep the canes as straight as possible. This procedure must be left to the discretion of the caner, as no diagonal should be allowed to swing to any great degree from a straight line.

Materials

Chair frame	Cane plastic 250′

Tools

Wooden pegs	Scissors or nippers

Procedure

Plastic cane does not require soaking.

Step 1. Determine the alignment of the center hole of the back and front rails and pull a strand of cane up through the center hole in the back, across the frame, and down the center hole in the front. Work both directions on the frame from this center strand of cane. It is advisable for the beginner to work from the center, both ways. He may begin otherwise after developing an understanding of the importance of absolutely parallel and equidistant strands between rails. In Fig. 100 it will be noted that in step 4 some holes on the side rails are skipped in an attempt to carry the canes the same distance apart throughout. Always use pegs to keep the strands taut. Their proper use has been explained in the seven caning steps.

Step 2. Follow the same procedure as in step 1 to determine the center row of cane and work both ways from it using all holes on the frame that are necessary to carry the cane at right angles to the strands of step 1.

Step 3. Again repeat step 1, but bring the cane strand to the top of the chair seat and follow the course of the strands of step 1 into the same holes.

Step 4. Follow the strands made in step 2 going under the strands made in step 1 and over the strands made in step 3 (Fig. 101).

Use a wooden peg to hold the cane strand taut (Fig. 101). At the

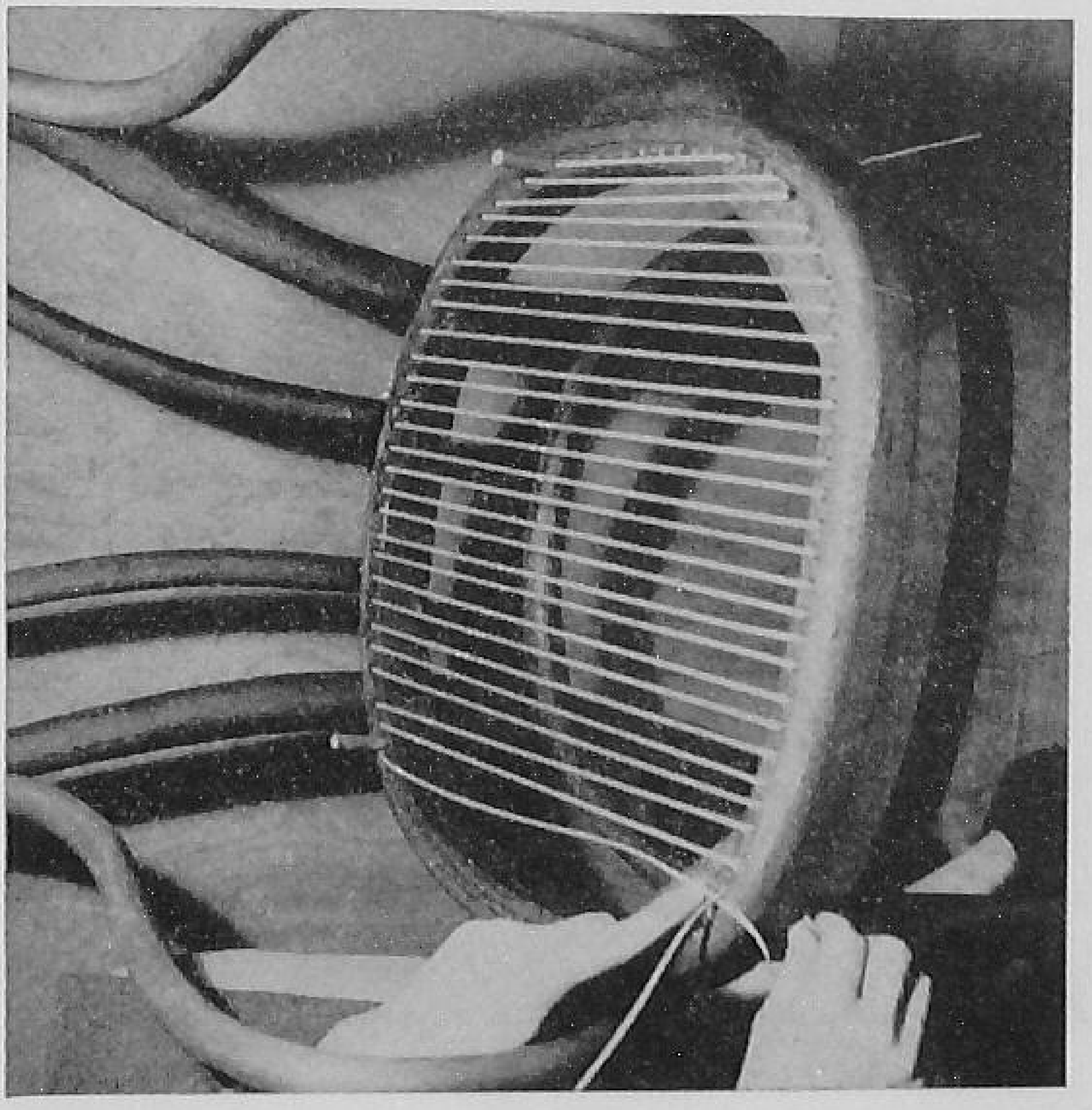


FIG. 100. Step I in an irregular shaped hand woven seat.

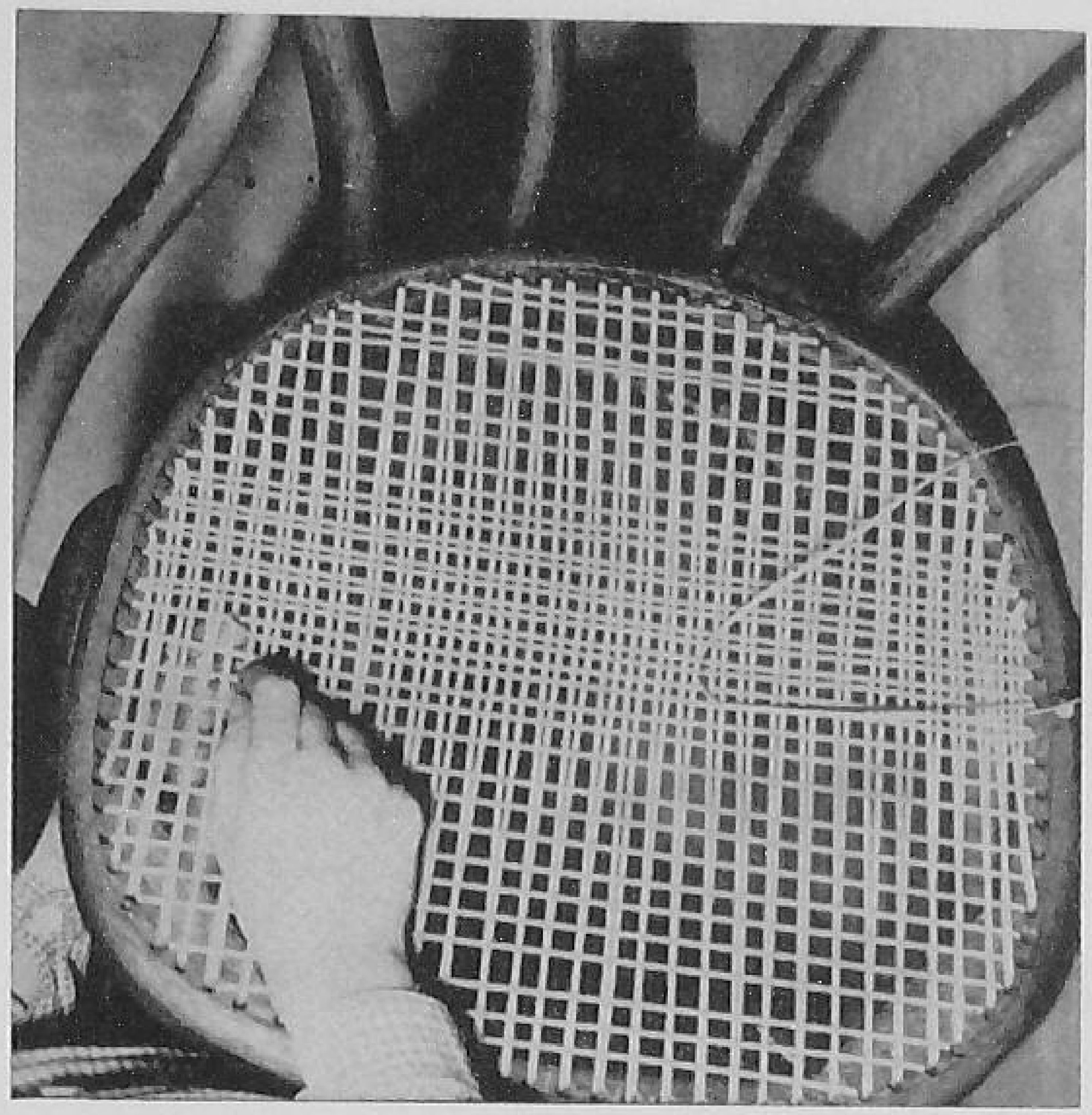


FIG. 101. Step IV in an irregular shaped hand woven seat.

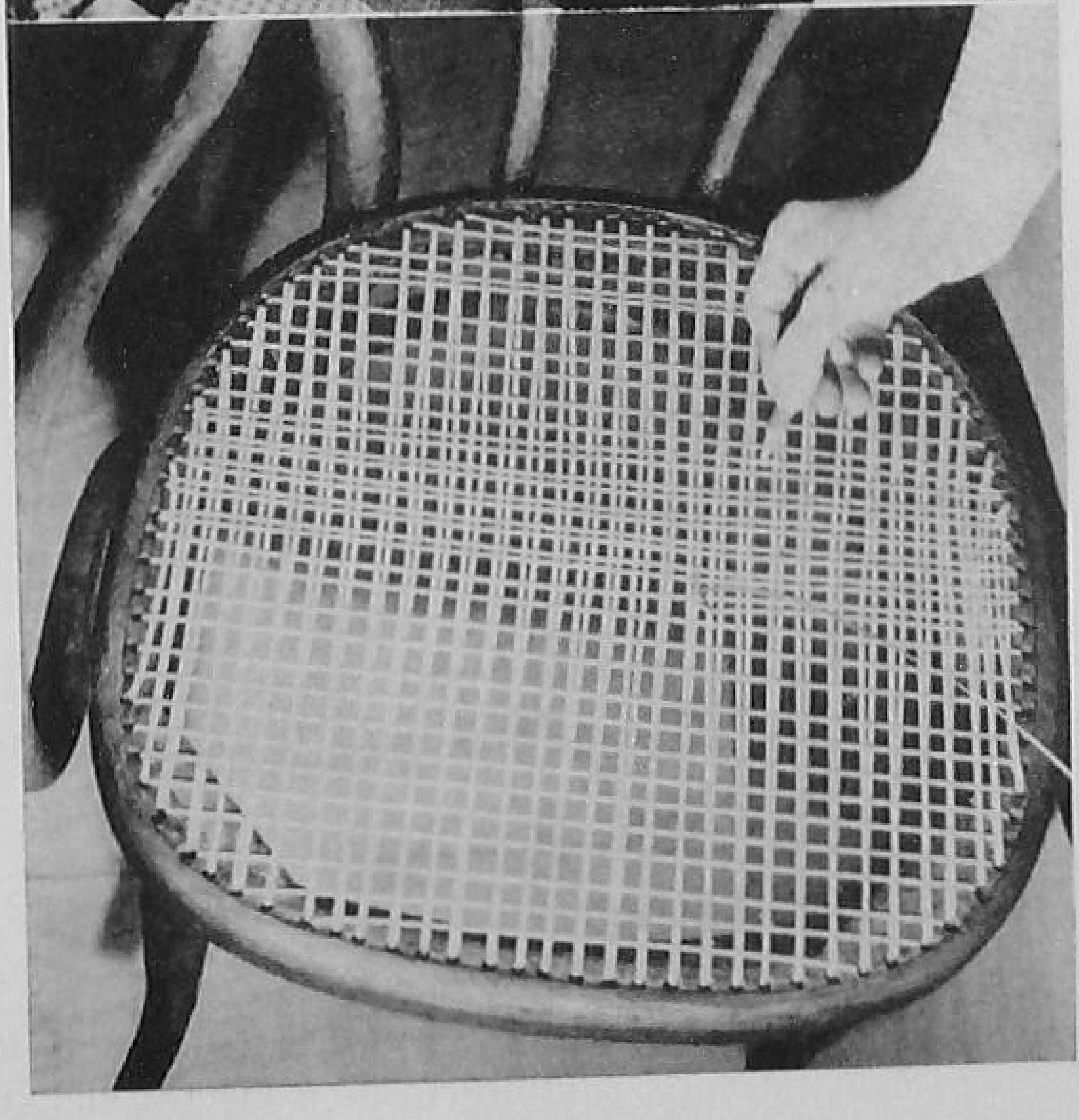


Fig. 102. Use of the wood peg to pair the woven squares at completion of step IV.

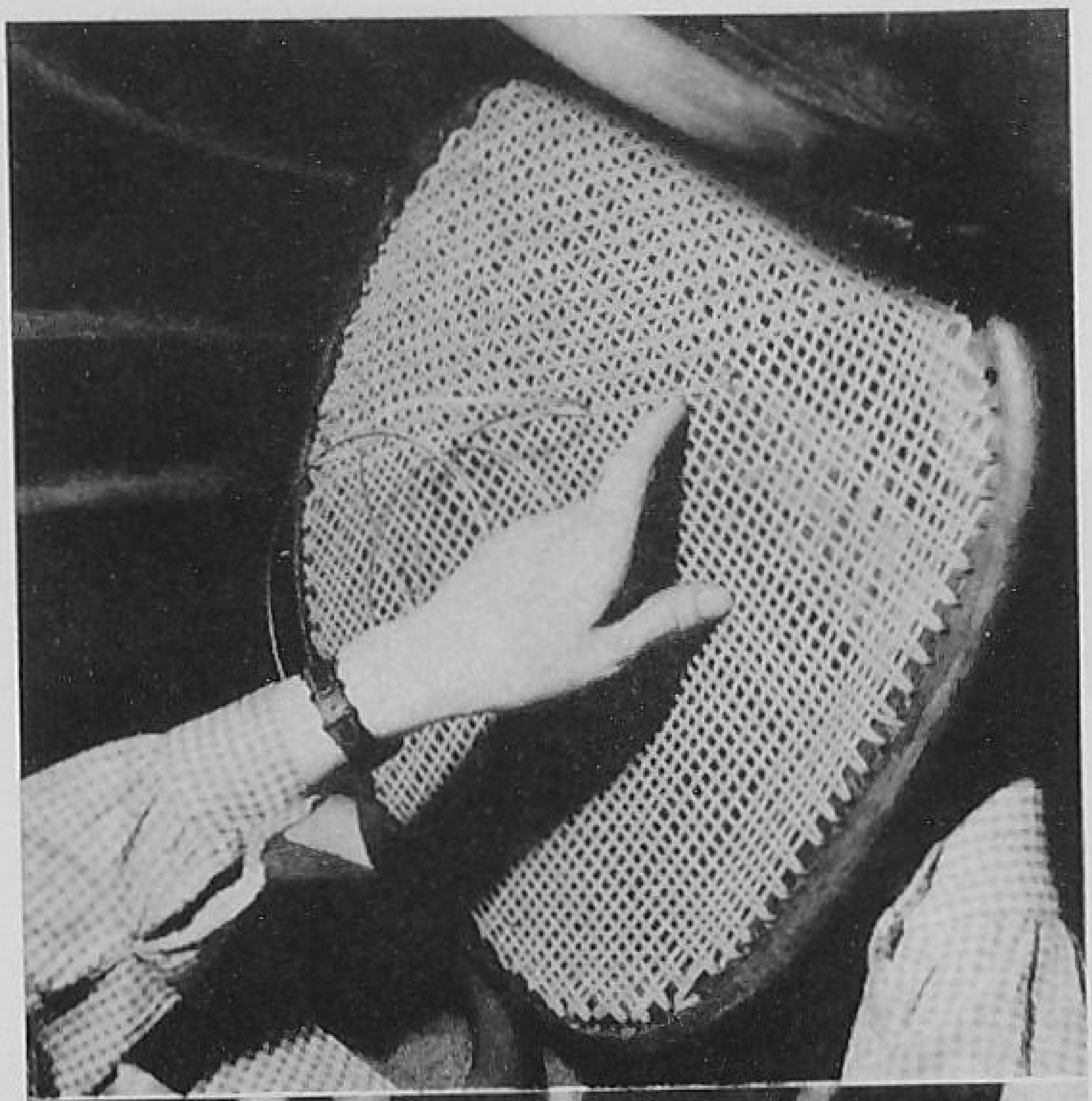


Fig. 103. First diagonals, step V.

completion of step 6 use the wooden peg to "pair" or adjust the cane strands to produce uniformly woven cane squares (Fig. 102).

Step 5. First Diagonals. The first diagonal canings go over the double verticals (strands running from front to back of chair) and under the double horizontals (those strands running from one side of the chair to the other). Start the diagonals at the right rear corner and progress to the left front corner (Fig. 103). But take care in weaving the first diagonal

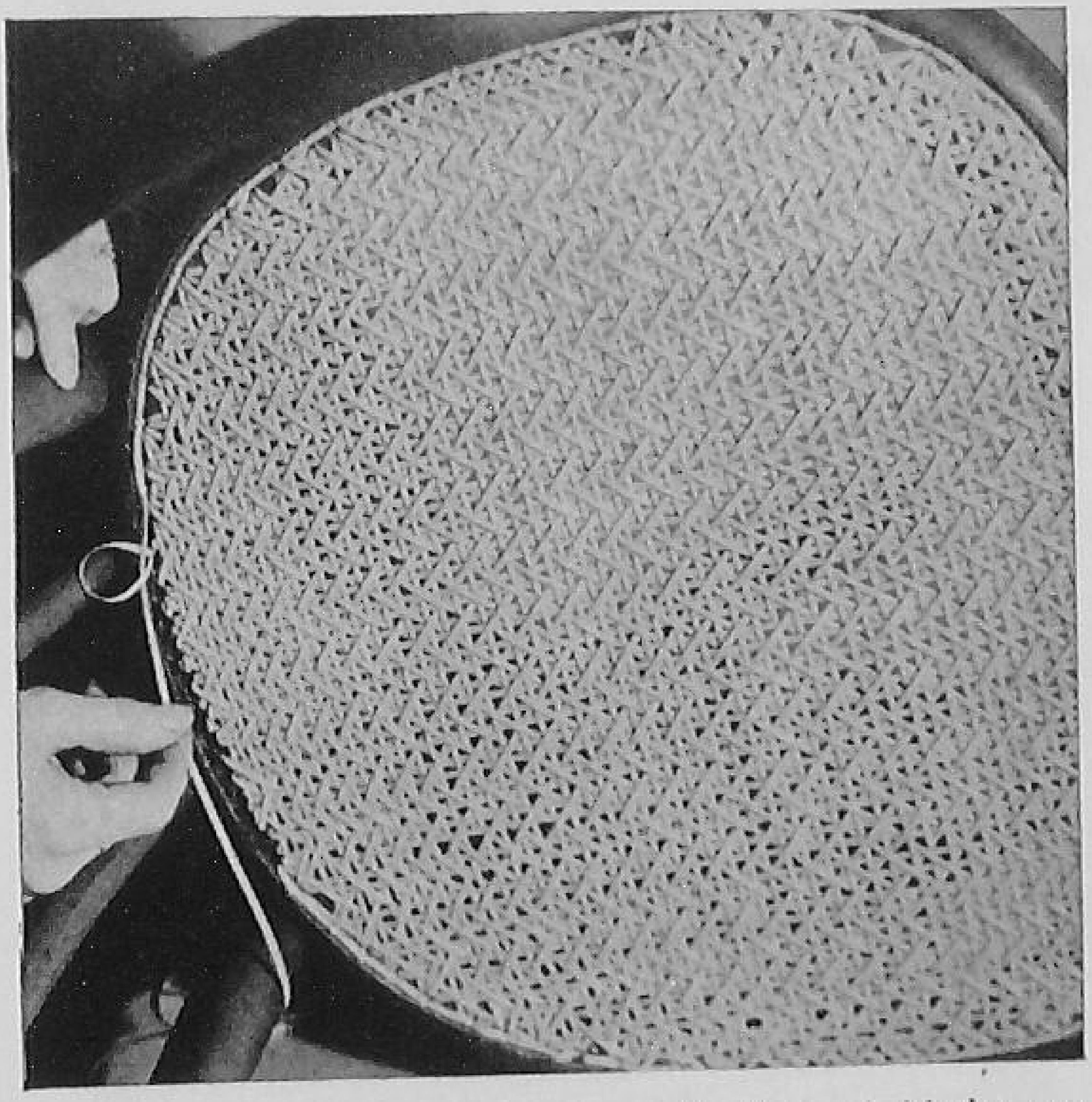


FIG. 104. Step VI completed—application of binder on curved edge.

to have it terminate in the proper hole on the curved back of the chair.

One hand is held under and the other on top of the chair seat (Fig. 103).

Step 6. Second Diagonals. On the chair shown in Fig. 104 a variation of the weaving of the second diagonals was made so that a chevron pattern was produced. After completion of the first diagonals, the cane was brought to the top of the seat at the left front corner and was carried over the double verticals (strands running from front to back of chair) and under the double horizontals (those strands running from one side of the chair to the other), progressing to the right rear corner. Note that

this weaving sequence is the same as that used in step 5, only going in the opposite direction.

In order to give maximum strength to a chair seat of this size the chev-

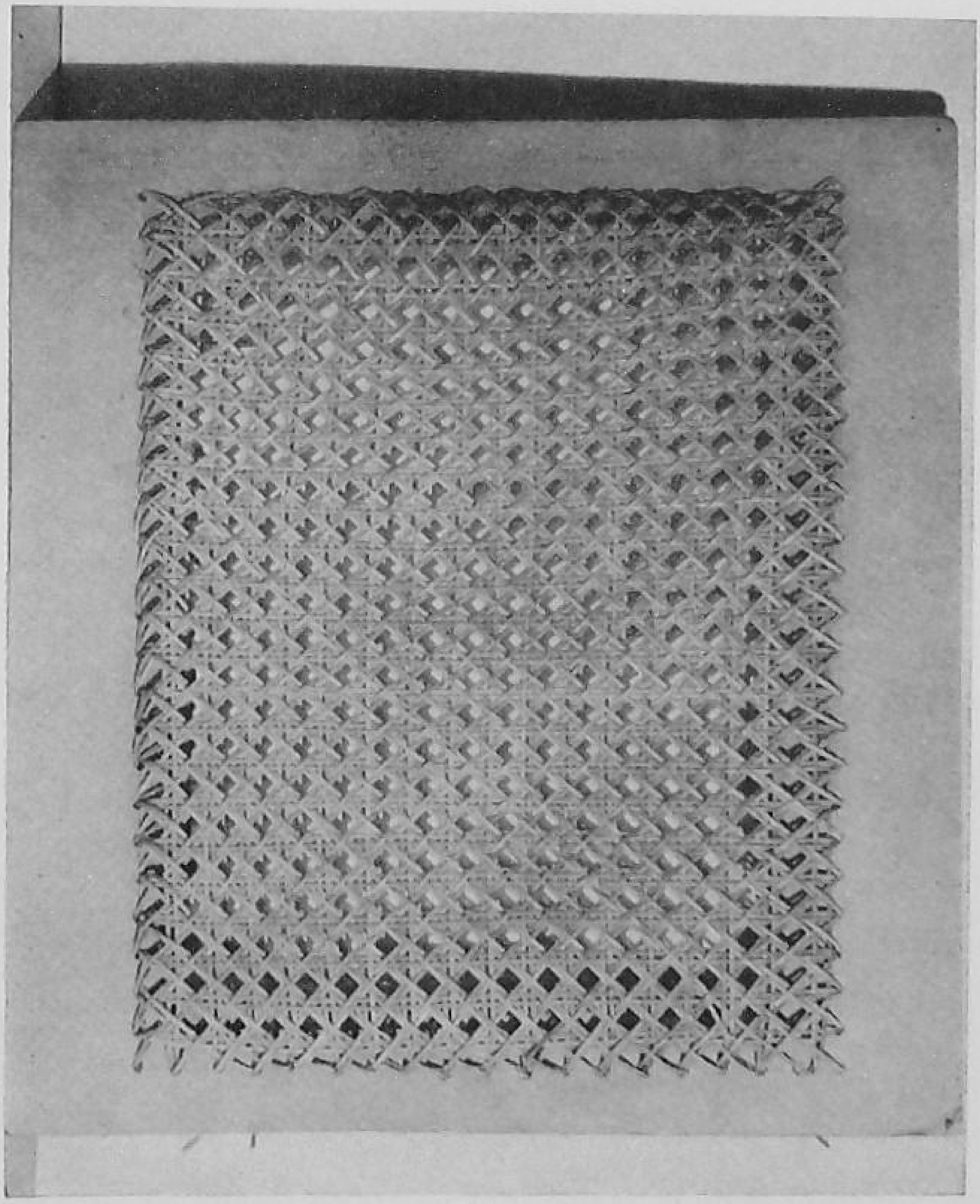


FIG. 105. Bench seat with two strands of cane used in each set of diagonals.

ron pattern was used so that longer lengths of cane are carried on the top of the chair seat.

Fig. 105 shows two strands of cane used in each set of diagonals to insure greater strength on a rectangular bench seat.

Binder

On a chair seat of this type and size application of a binder is a necessity. The strands of cane must be protected at the points of greatest wear. Then too the binder covers the holes in the frame and gives a finishing touch to the hand-woven seat.

Hold over the row of holes a strand of cane long enough to reach around the entire seat edge and curve it to fit the contour of the chair. Insert a second strand of cane up through a hole near the back and carry it over the binder strand and back down through the same hole. The second strand forms a loop, and when this loop is pulled down flat it secures the binder. Repeat this operation all around the seat. On a curved edge it is advisable to secure the binder at every other hole in order that there be sufficient space for the binder to follow the curve of the chair frame (Fig. 104). When the first end of the binder is reached, lap the last end over it and secure it by covering both ends with the final loop. Then cut off the top binder strand close to the final loop.

On the heavy chair frame shown in Fig. 104 it did not seem necessary to plug the holes after the caning was completed.

Reseating a Chair with Machine-Woven or Pressed Cane

This method of caning refers to the application of a full seat pattern by wedging or driving the woven cane into a groove in the seat frame. A length of reed spline (Fig. 107) of the proper size is pressed into the groove to cover the ends of the cane.

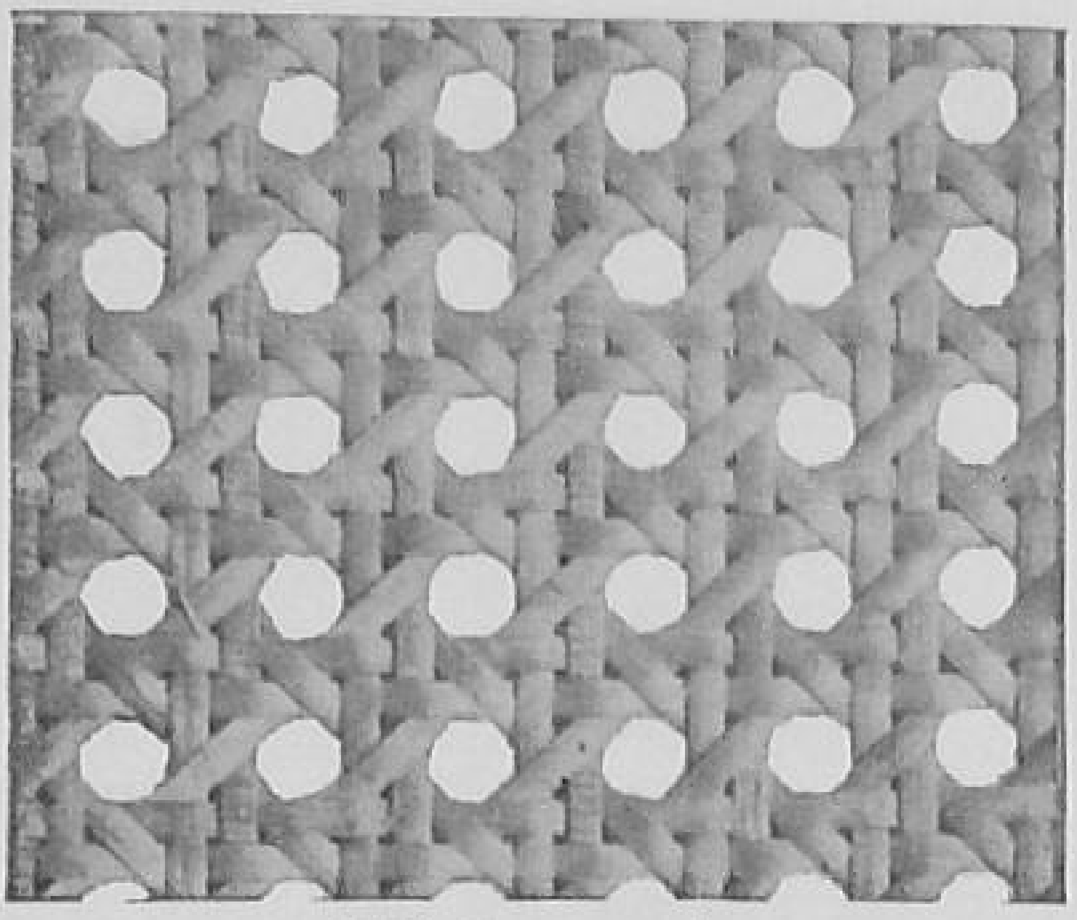
The replacing of seats in chairs with machine-woven or pressed cane is a much simpler process than hand caning the same areas.

Machine-woven cane is manufactured on large power looms and is sold under the name of cane webbing. Cane of various sizes is used in the fabrication so that several sizes of mesh are available:

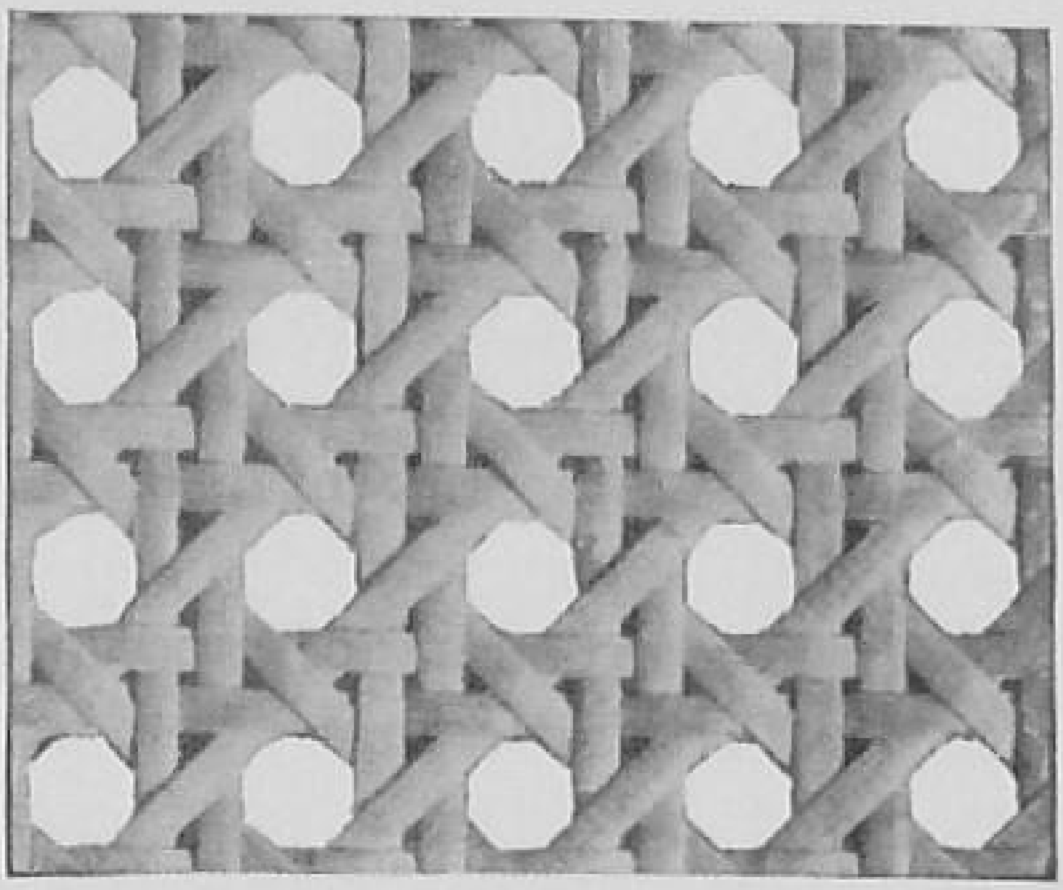
Superfine cane is woven in a 3/8″ open mesh.
Fine-fine cane is woven in a 7/16″ open mesh.
Fine cane is woven in a 1/2″ open mesh.
Narrow medium cane is woven in a 9/16″ open mesh.
Medium cane is woven in a 5/8″ open mesh.

See Fig. 106 for comparison of sizes.

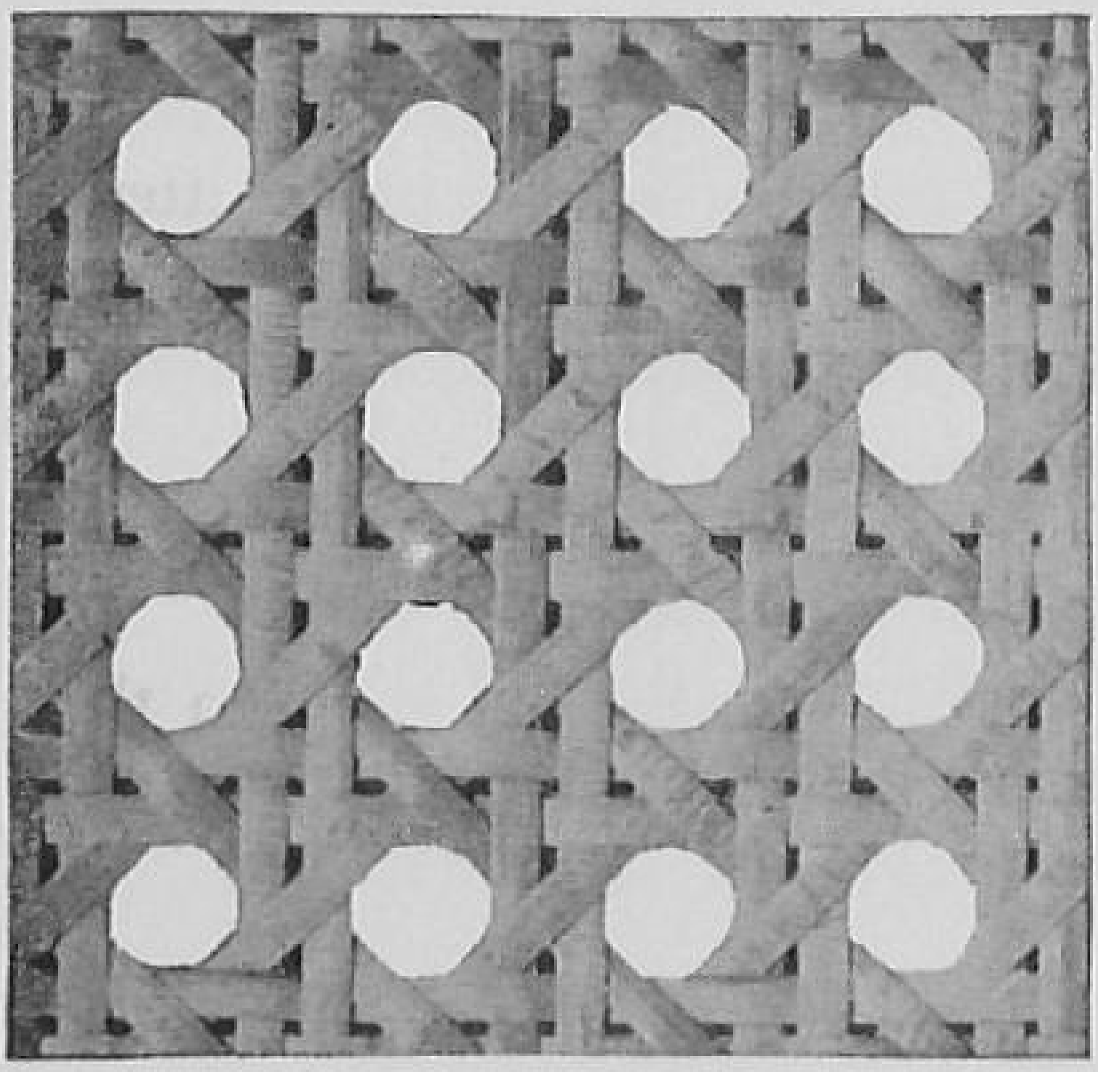
Open-woven cane webbing is sold by the running foot and is woven in widths starting at 8″, increasing by 2″ widths up to 18″, and is obtainable in rolls of various lengths.



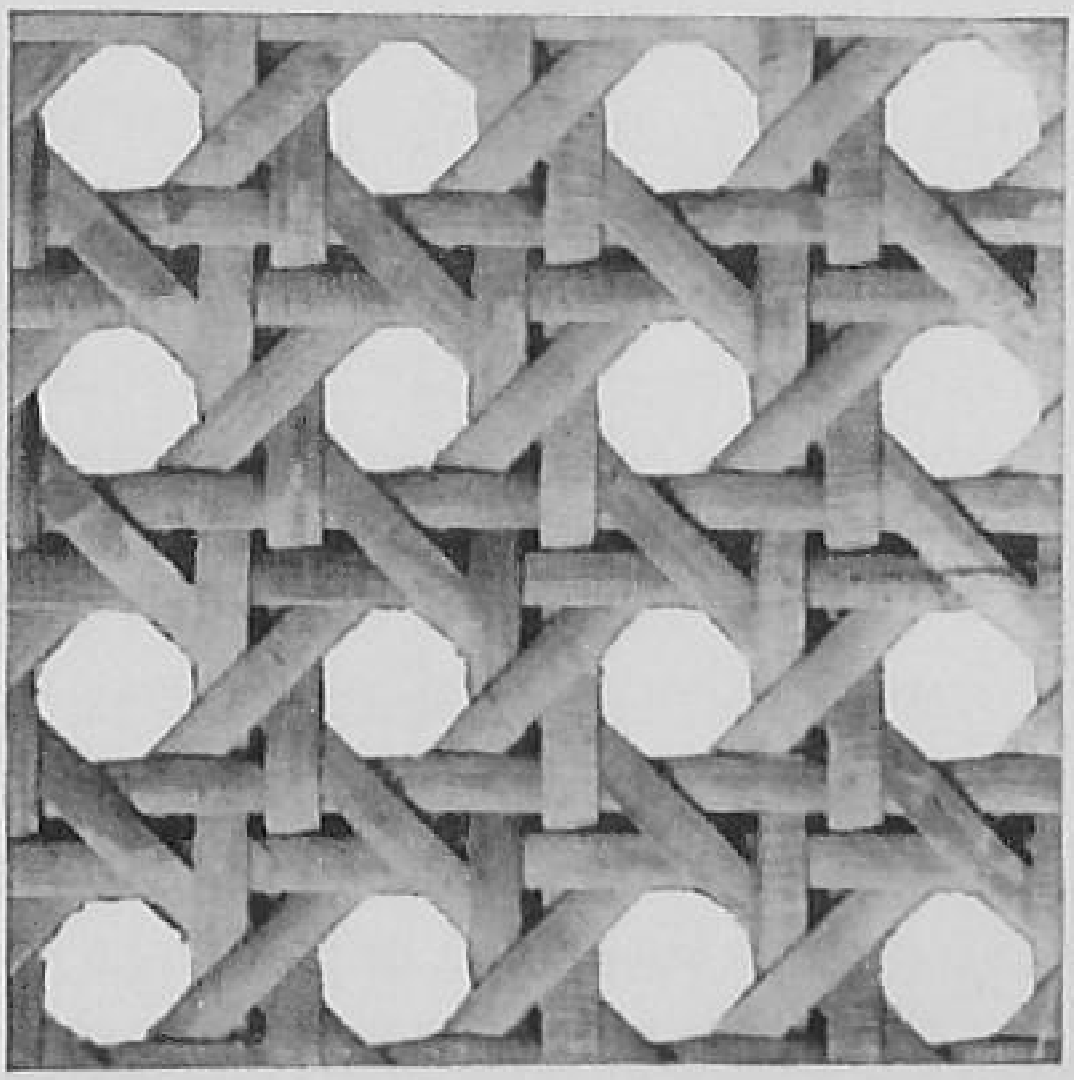
⅜″ Open mesh.



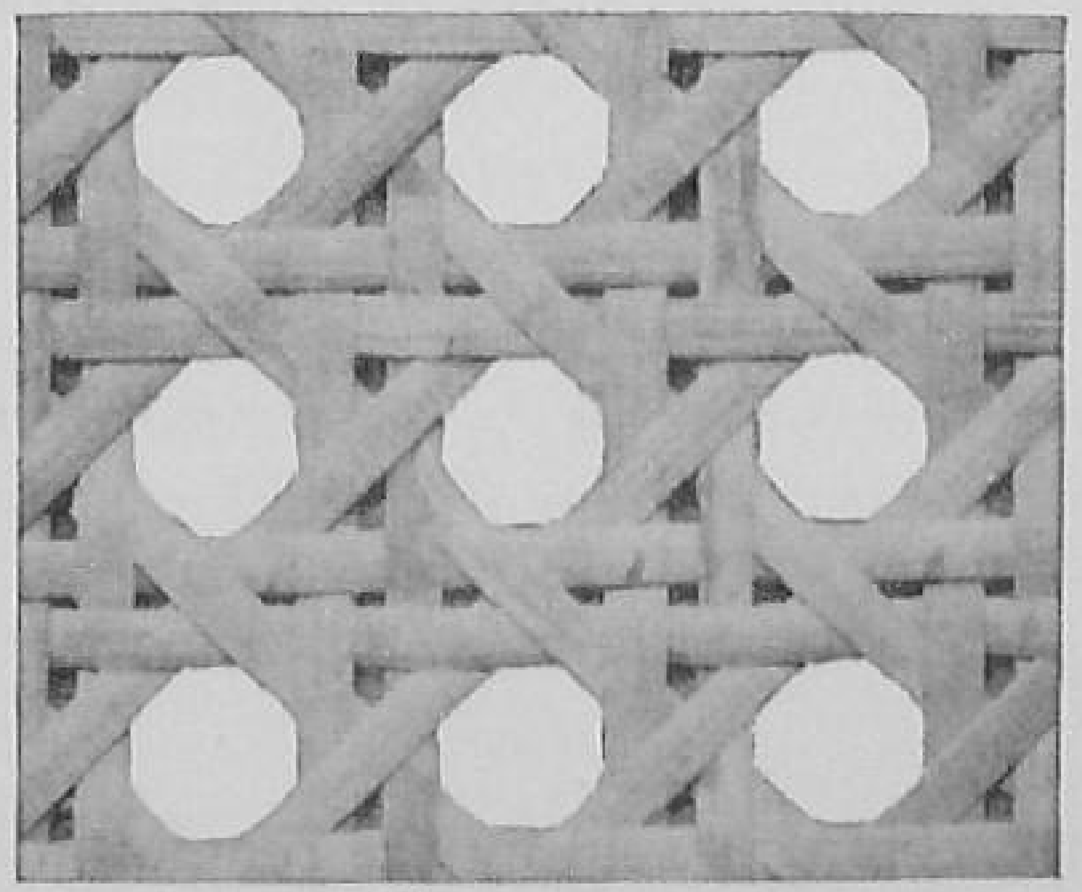
7/16″ Open mesh.



½″ Open mesh.



9/16″ Open mesh.



⅝″ Open mesh.

FIG. 106. Sizes of machine-woven cane.

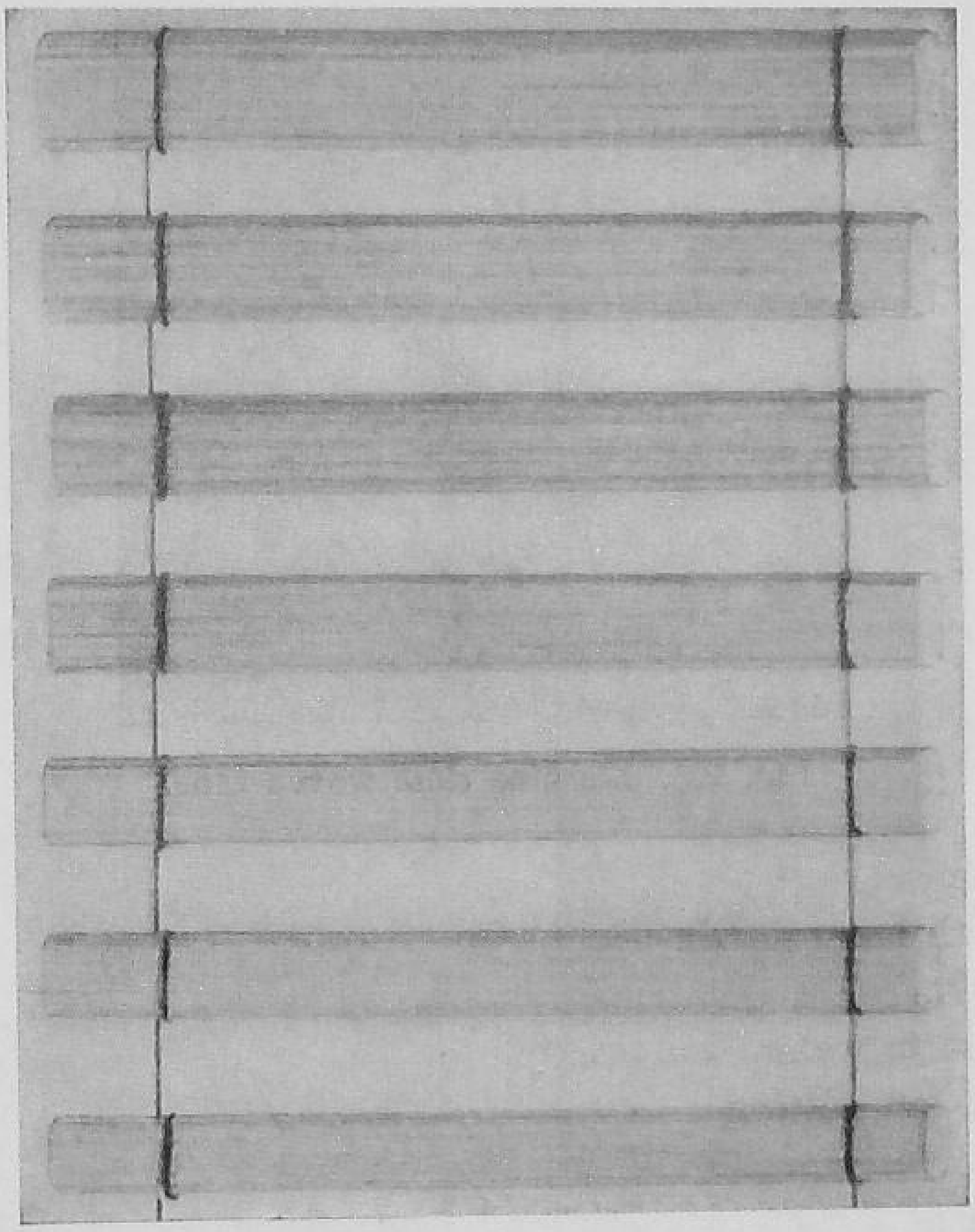


FIG. 107. Spline.

Close-woven cane webbing, in either plain or diagonal weave, is sold by the square foot, regardless of width. It is woven of fine or medium size cane in widths from 10″, increasing by 2″ up to 24″ (Fig. 108).

Materials

Seat frame

Cane webbing $\frac{7}{16}$″ or $\frac{3}{8}$″ open-mesh or close-woven cane webbing (the measurement of seat plus $\frac{1}{2}$″ marginal excess on each side).

Reed spline (measurement of edge of cane plus 1″ for splicing).

Tools

Knife

Chisel

Rawhide or fiber mallet

Hardwood spline wedges of various sizes

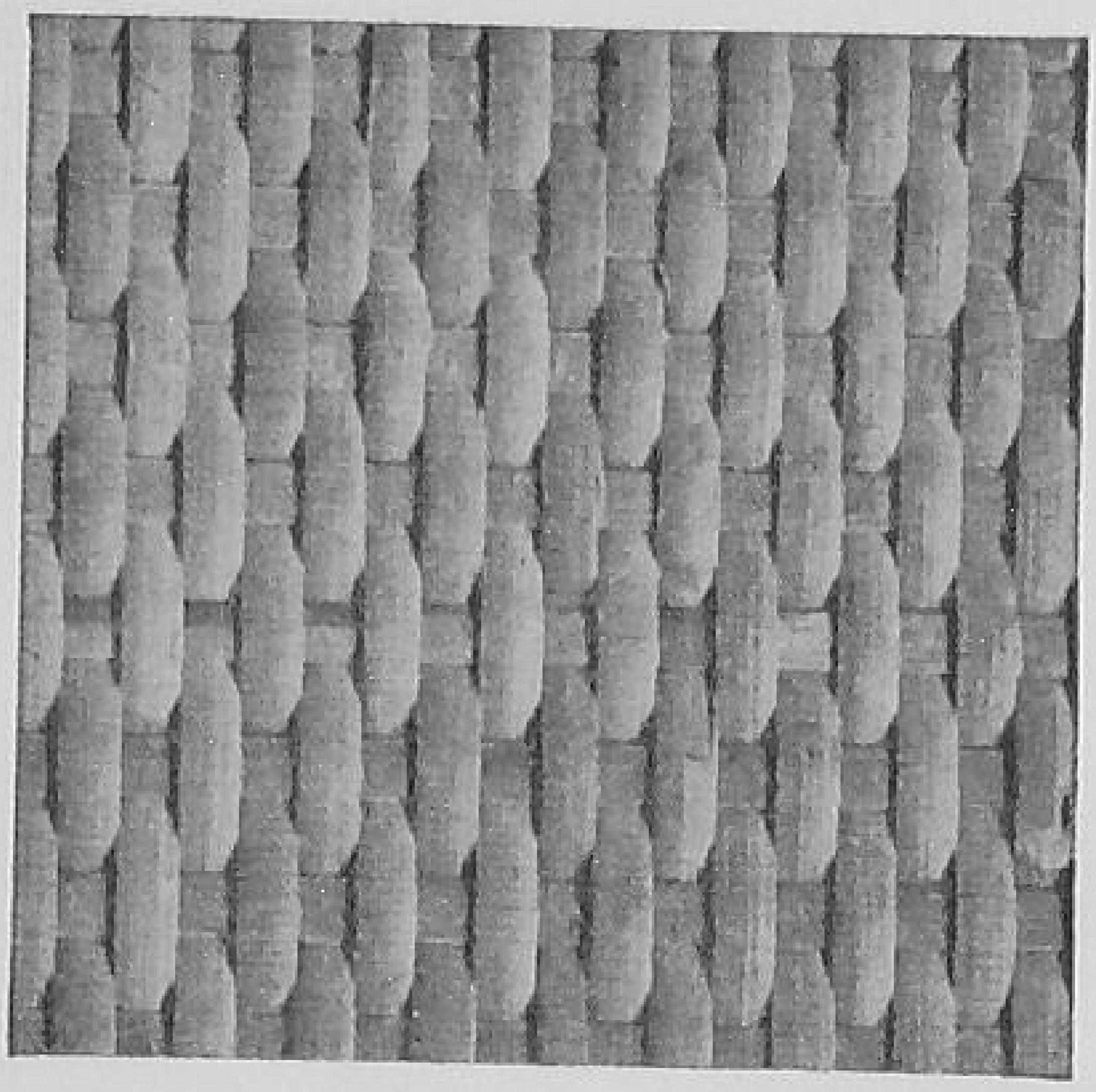


FIG. 108. Machine close woven cane.

Liquid glue
Oil can with large nozzle
Small brush
Basin of warm water
Cardboard for pattern

Preparation of Frame for Pressed Cane Seat

Step 1. Remove all the old cane and spline from the groove around the chair or bench with a 3/16″ chisel and mallet. To do this either hold the chisel at right angles to the groove and tap lightly with the mallet, lifting up small sections of the old spline; or holding the chisel parallel with the spline and as near the center of it as possible loosen the spline with light blows until the sections can be removed (Fig. 109). A small amount of water allowed to flow along in the groove after some of the spline has been lifted out will aid in removing the more stubborn pieces. Be careful not to chip the seat rails in removing the old spline. Be sure that all of the old glue and pieces of spline are thoroughly removed from the groove.

Step 2. Wedging Cane into Groove. An oak-tag or bristol board pattern of the chair seat shape (Fig. 110) will prove of material assistance to the beginner in order that an accurately cut shape may be obtained. After soaking the cane webbing in water for an hour or boiling it for a minute or so to make it pliable, place it over the seat, being sure the strands run straight with the groove. If a centerline on front and back of the frame is marked, the same strand should touch both markings. The

front line on the edge of the pattern must run parallel with the horizontal or vertical strands of cane.

Cut the cane webbing the shape of the cardboard pattern allowing ½″ excess around the entire piece. Even up the edges by pulling out all cane strands at the edge of the piece of cane webbing that run parallel with and beyond the groove for their full length. Do not remove any strands that may extend beyond the groove line for only part of their length as

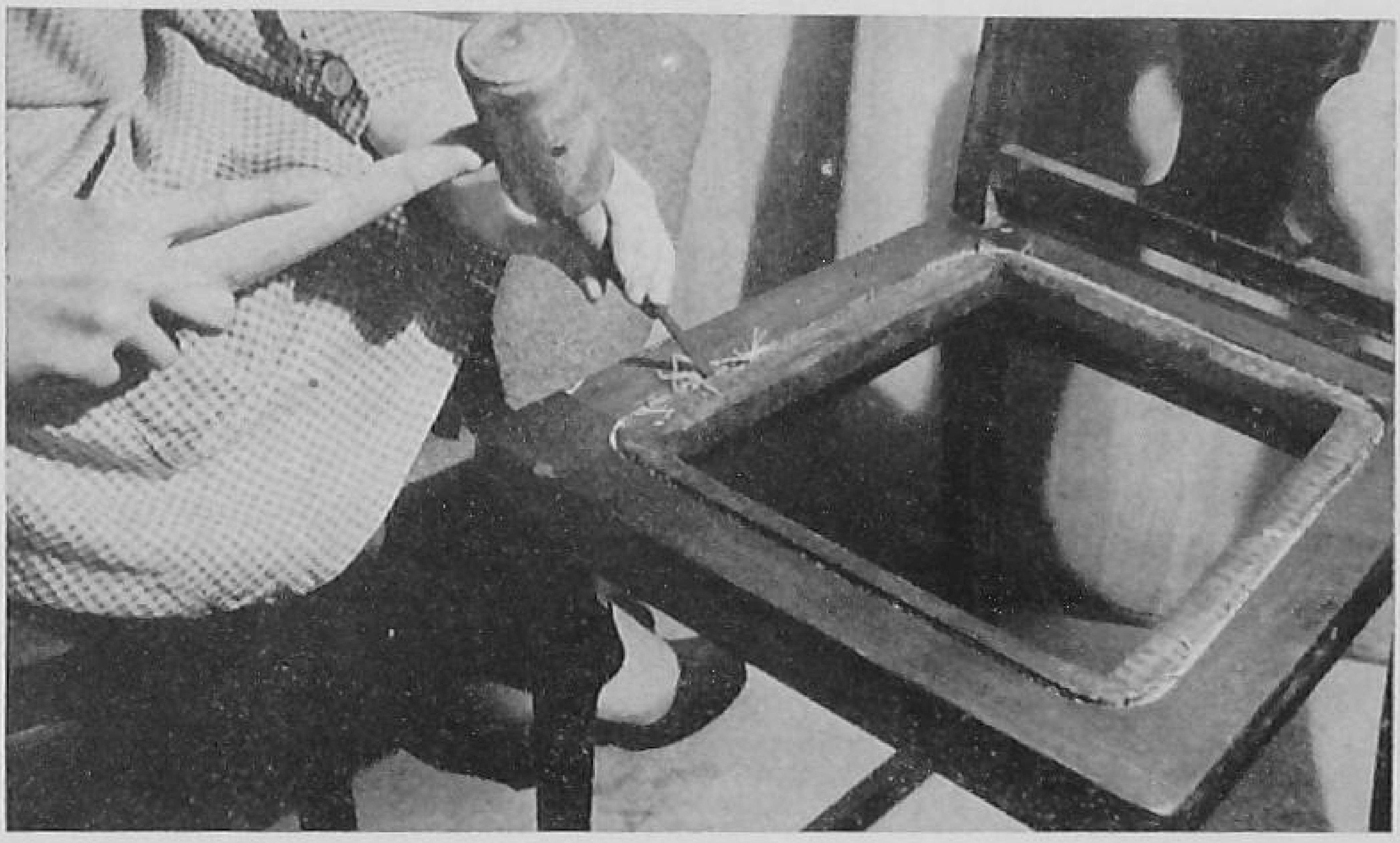


FIG. 109. Remove old cane and spline from groove around chair.

the strength of the cane webbing will thereby be reduced at that area. Lay the webbing over the frame and see that the strands run parallel to the back of the frame. It is to your advantage to start wedging the cane into the groove at the back of the chair because a better tension can be obtained in pulling the webbing toward the front rail where no back upright rungs or arm rests are encountered. Since the curved corners are the last sections to be wedged, only the parallel strands are wedged into the back-rail groove. The wedge may be temporarily left in to aid in retaining the straight line when tension is applied in pulling the webbing taut to the front (Fig. 111). Then wedge the front edge into the groove, making sure that the same cane strand touches the centerline on both back and front of the frame. Next wedge the two sides and finally

the curved sections. Allow the cane to dry with the wedges holding it, at least overnight, before resuming work on the seat.

Step 3. Trimming the Woven Cane Ends. The edges of the webbing still project beyond the groove. Cut these slightly above the bottom of the back wall of the groove with a knife or mallet and chisel. After cutting, give the ends of the cane a final wedging, tapping lightly so as not to break the dry strands.

Step 4. Fitting the Spline. Soak the reed spline thoroughly and gently shape it along the curves of the groove, with the splicing made at the back of the chair or on the straight edge of a stool (Fig. 112). Skive both ends of the spline. That is, they reduce in thickness so that their overlapping of at least an inch is no thicker than the original reed. After obtaining a perfect fit with the spline, remove it in order to glue the cane ends.

Step 5. Glueing. With a large-nozzle oil can, pour either liquid hot or cold glue in small quantities all the way around the groove. Be careful to fill not more than a third to a half of the depth, or it will be forced out when the spline is replaced. Since hot glue sets more rapidly, the cold glue is recommended for use by the beginner, so that no great haste is required. If an oil can is not available, a small, stiff brush will serve the purpose of spreading the glue in the bottom of the groove. On a rocker or tilt-seat, blocks are placed under the rear rockers or legs so that the seat will be level. The glue will not flow evenly in the entire groove unless the chair is level.

Step 6. Inserting the Spline. Splines may be had of either wood or reed. They are curved on the upper edge and wedge shaped in cross section (see Fig. 107). Wood spline, preferably of hickory, may be purchased in 5-foot lengths, and reed splines in lengths of 8 to 10 feet. They are standard in width and thickness and will fit a groove $\frac{1}{4}''$ deep and $\frac{3}{16}$ to $\frac{1}{4}''$ wide. Both hickory and reed are easy to handle because of their pliability, which is increased by soaking in hot water until thoroughly workable. When the glue is slightly tacky insert the spline in the groove taking care to make the joining at the rear of the seat. Drive the spline down into the groove very tightly with a mallet, using a small piece of smooth wood to prevent bruising the spline, as shown in Fig. 113. Sponge off the excess glue that will be forced to the surface and allow the webbing to dry overnight before using the chair. As the cane webbing dries it becomes taut. If any irregularities of the surface did not

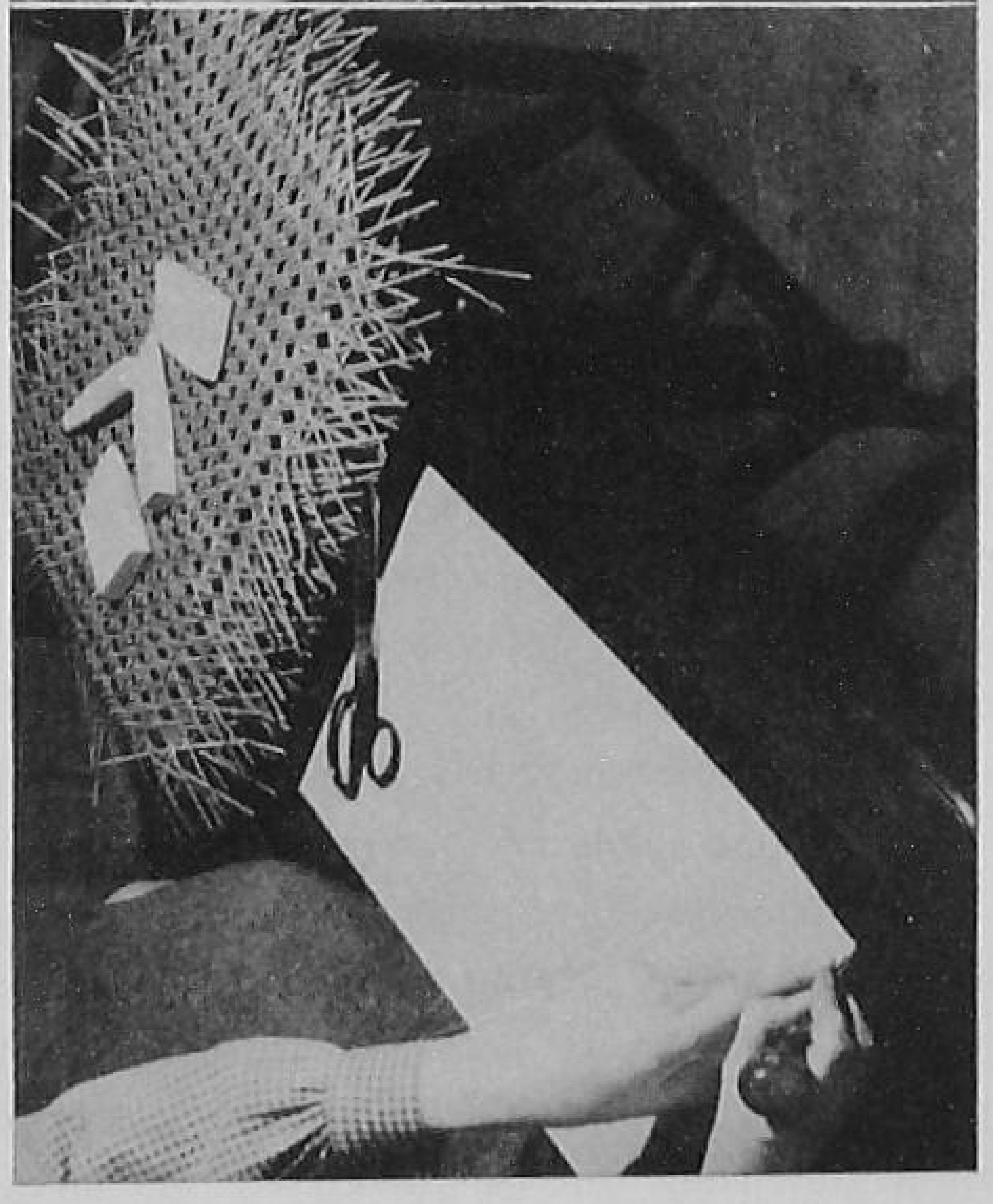


Fig. 110. Bristol board pattern of chair seat.

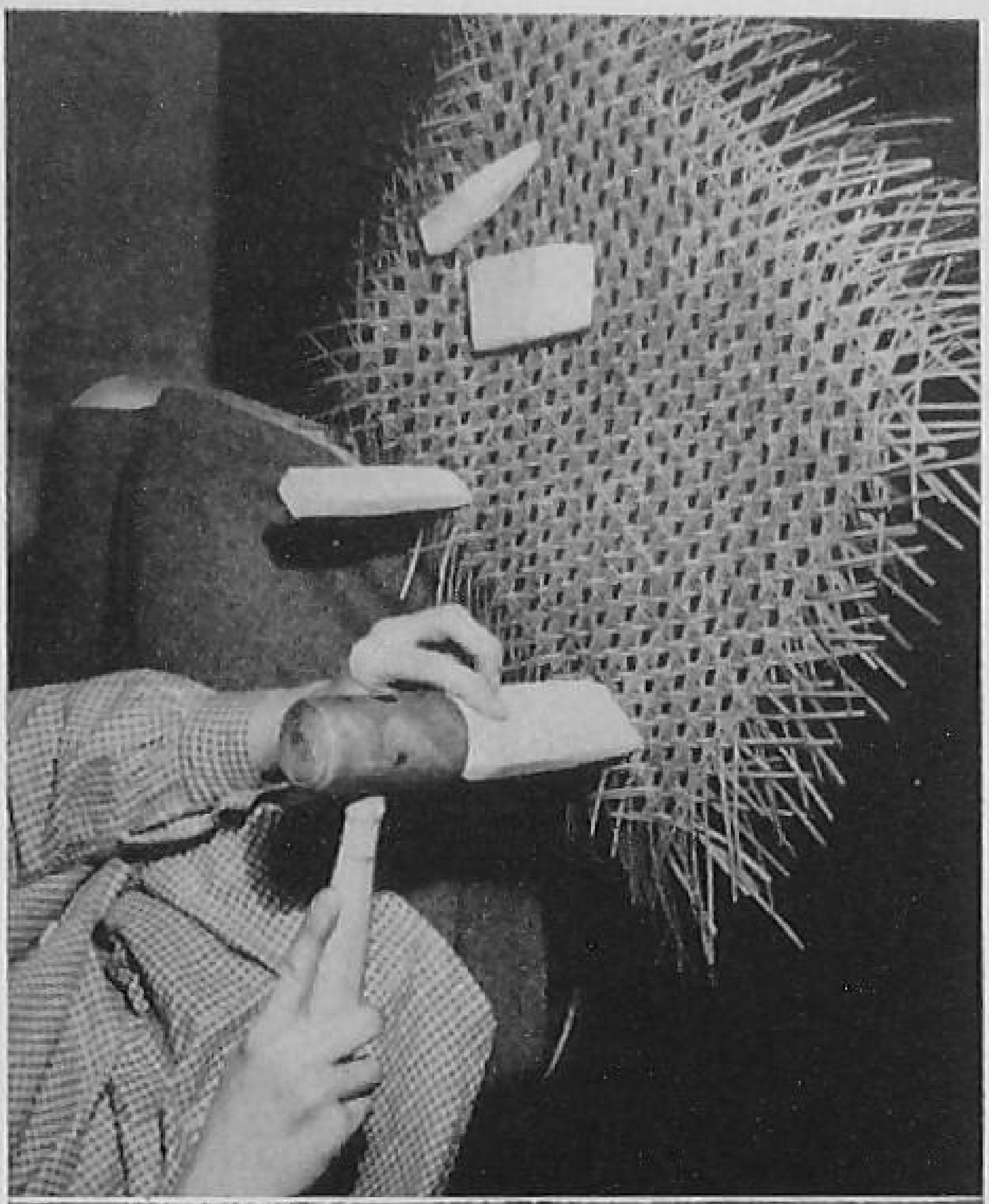


Fig. 111. Wedge left in temporarily.

disappear in the first drying, moisten the webbing again on the underside and place it in the sun or near heat.

Step 7. Finishing. Light rubbing with fine sandpaper will remove the hairlike projections on the cane strand. A thin coat of shellac will preserve the natural color of the cane. If the chair is to be stained a dark shade the cane may be stained at the same time. In most cases, however, all refinishing of the chair frame is completed before the replacing of the seat begins.

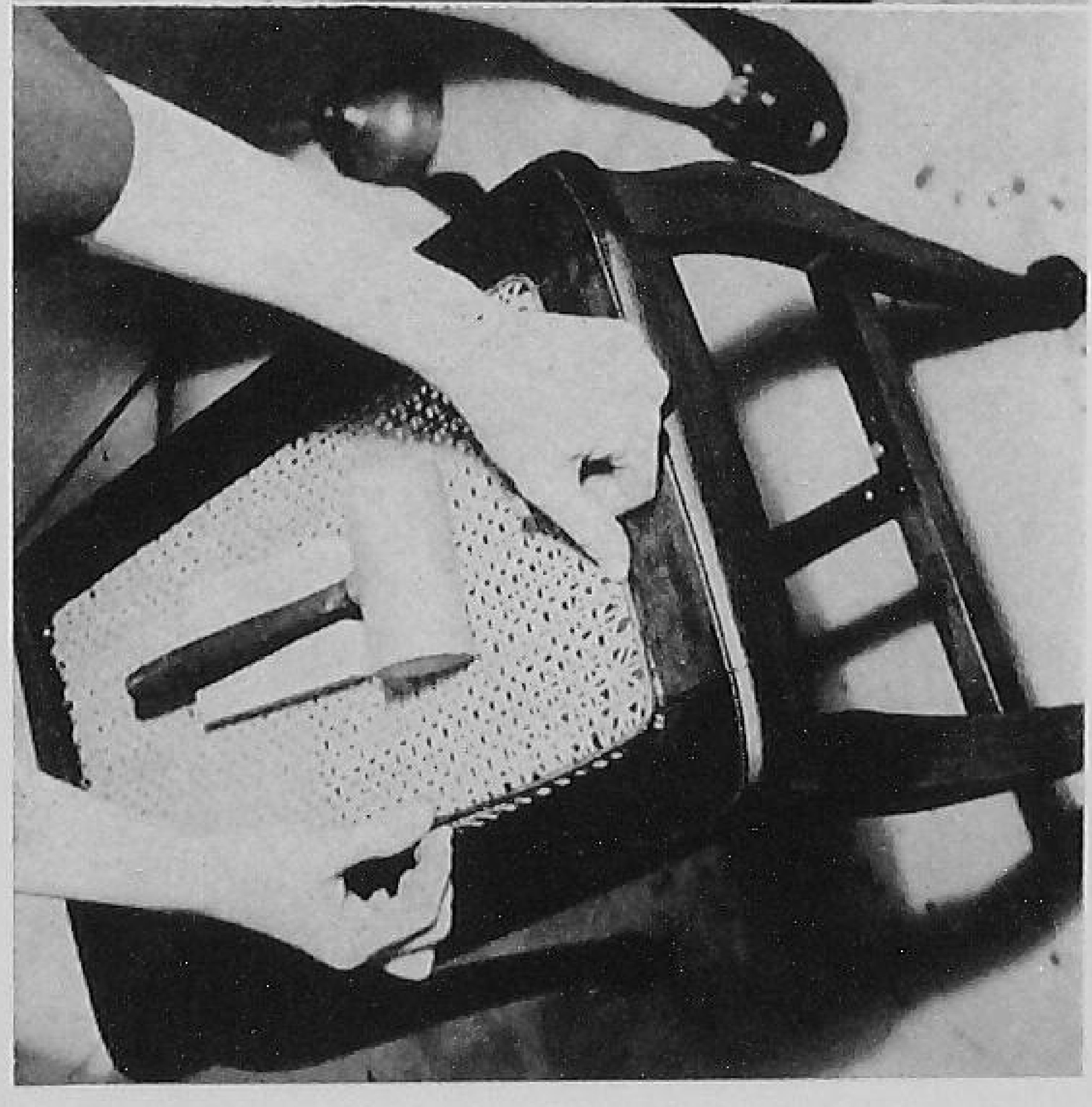


FIG. 112. Fitting the spline into groove.

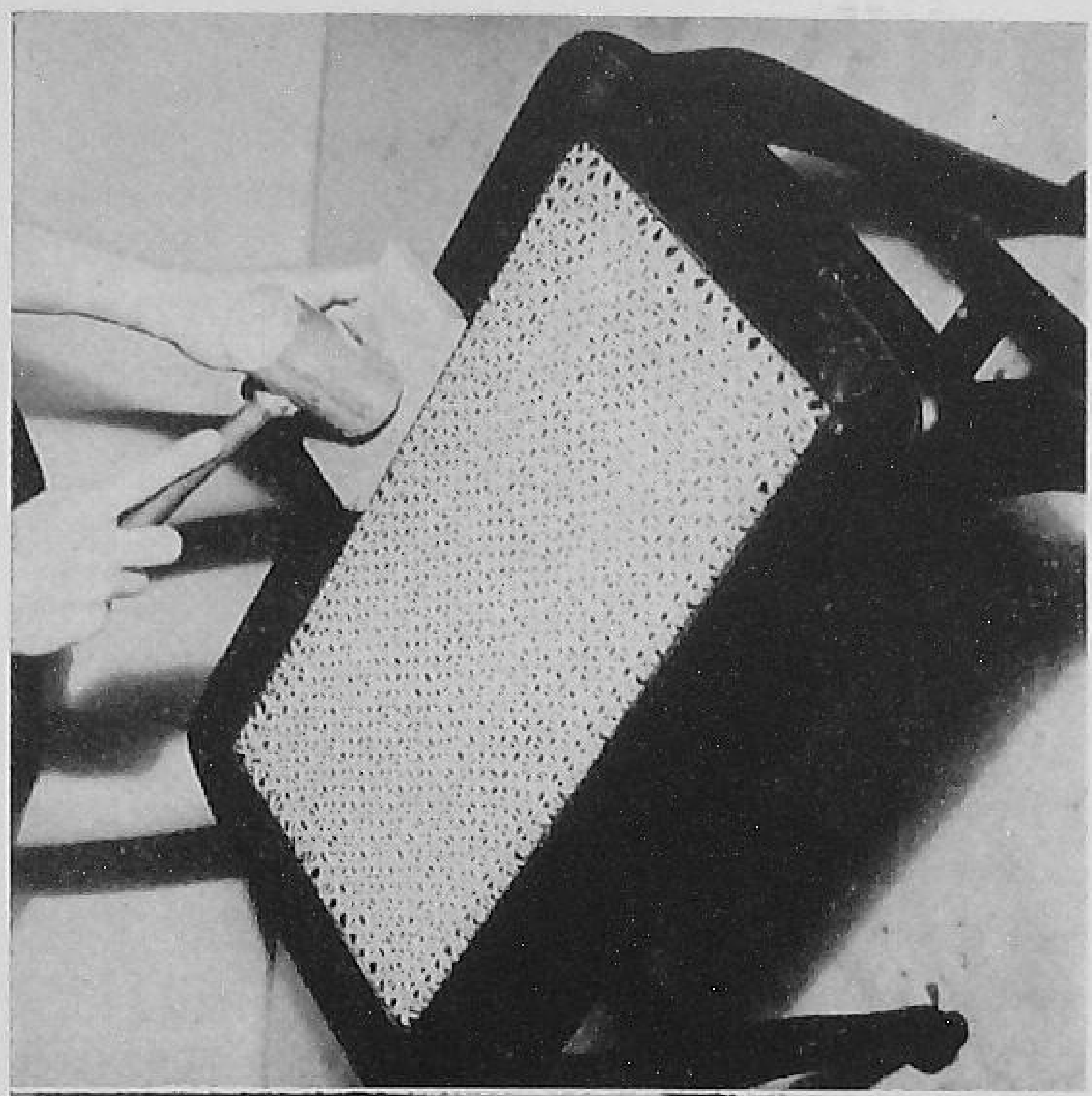


FIG. 113. Inserting the spline.

Chapter IX

RUSH AND ITS USES; PROJECTS

Rush is any one of a number of plants of the genus *Junceus,* having smooth filaments, and generally a three-celled capsule with many seeds. Some of the plants popularly known as rush are the cattail and the flag. They are found in wet places throughout the Northern Hemisphere, along banks of sluggish streams, and in lowlands and marshes. Some species are found in tropical regions. The species are numerous and vary greatly in appearance. Some plants are tall, slender, absolutely leafless, green growths standing out of the water, often 8 or 10 feet. Others are broad-leaved and still others are low thick stalks crowned with small heads of brown flowers. It is rather surprising to find how color and texture, as well as length, vary in different parts of the country. It may be that this difference in appearance is due in part to the particular kind of soil on the river beds, or the chemical content of the water.

The salt-water rush, or golden, is grown in Holland. It is very tough and attractively colored, and is chiefly used in seating. The stalks of this golden rush are shorter and therefore need joining more frequently, but the lovely color and long lasting quality of this salt-water rush repay the craftsman for the additional splicings.

In many parts of the country, home-grown rushes, green ones, are used for seating. No doubt, those of the species that are really strong answer the purpose quite well. But it is doubtful if they last as long as the Holland variety. The stems of the true rush contain a large pithy core that is sometimes used for wicks for small candles, called rush lights. Rush may be colored and split for use in basket making. Many basket makers prefer the natural green shade of the rush. A species of soft rush is cultivated in Japan for making mats.

Although at present rush is extensively employed in furniture, rush work is by no means a modern art. The student has only to visit our museums to see specimens of rush work that are several thousands of years old. The English furniture makers used rush on several types of

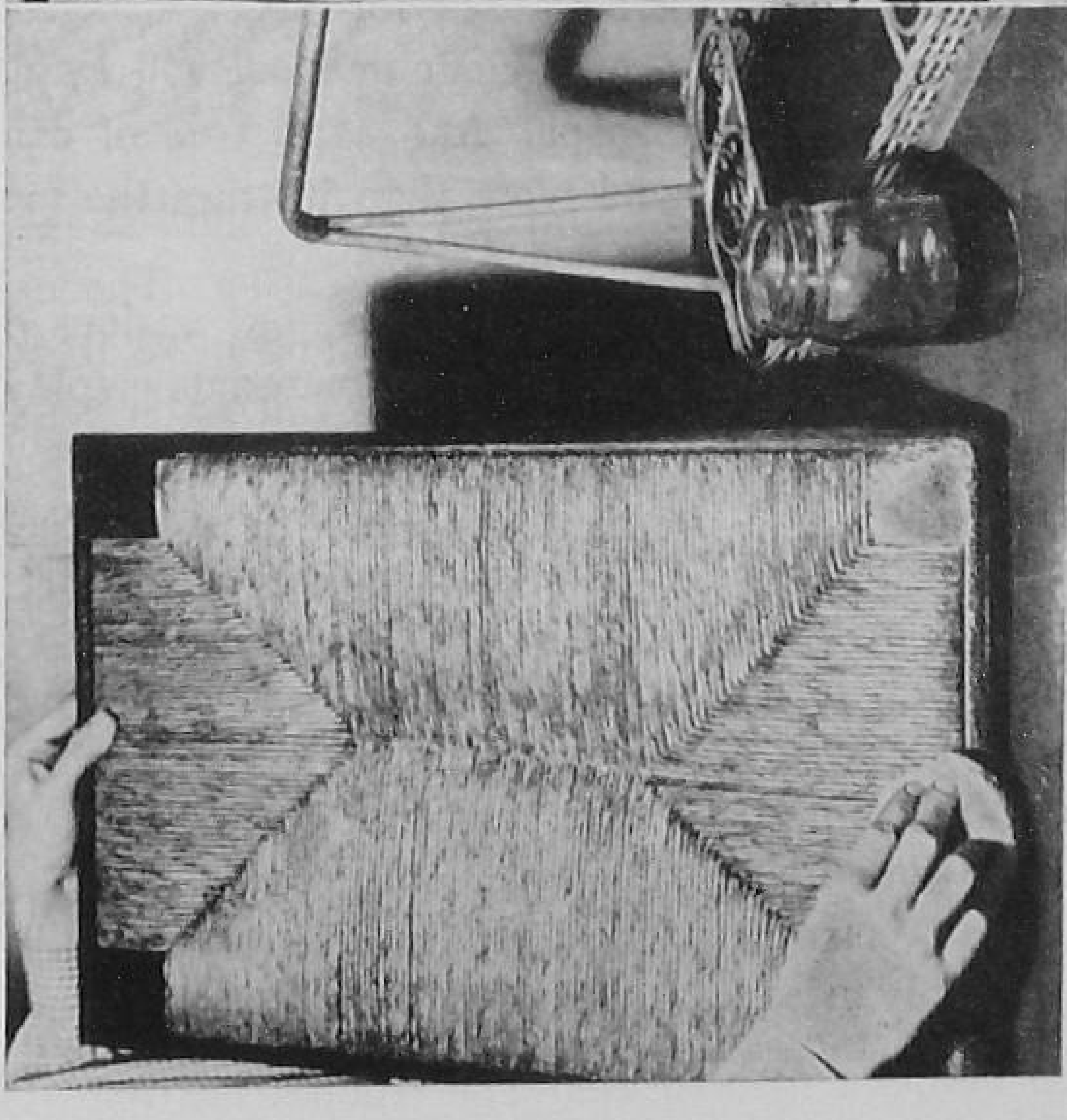


Fig. 114. Rush coffee table top.

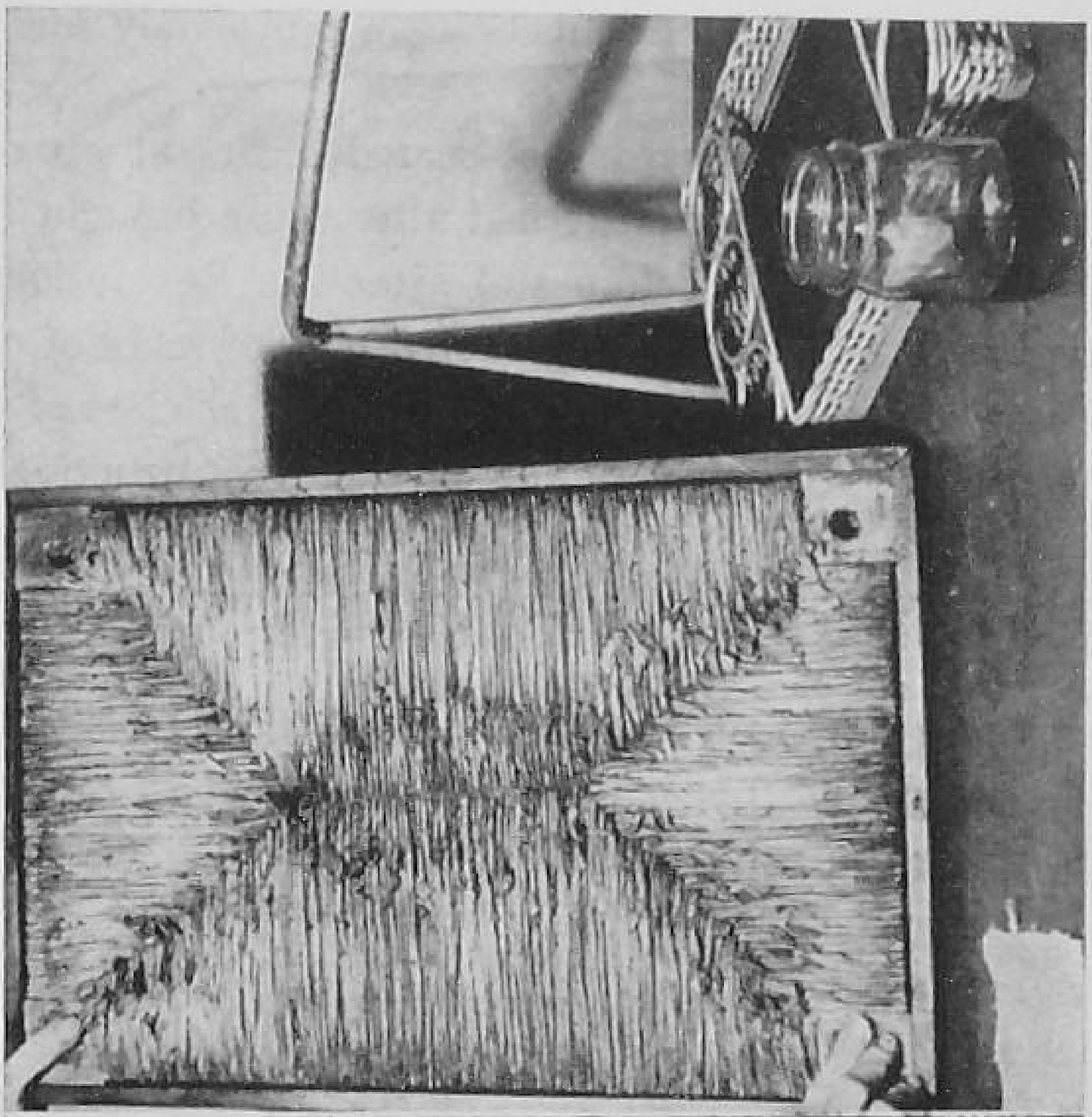


Fig. 115. Underside of rush coffee table top.

chairs between 1720 and 1870. About 1750 in Normandy and Brittany rush was used for seating.

The American colonists produced rush-seated chairs at an early date and the chairs were undoubtedly patterned after those brought over from Holland, France, and England before and after the Revolutionary War. In Colonial times rush always was a functional part of seats of chairs and stools. It was very seldom, however, used on the better class of furniture.

Although the use of rush is one of the very old constructive crafts, it had become almost lost, chiefly because the machine age outmoded it, but more particularly, perhaps, because of the very poor wages that were paid for this hand work.

Today furniture of excellent design and workmanship is constructed with hand-woven rush seats. These are either woven over a separate frame and inserted, or are an integral part of the chair, being woven over the seat rails of the chair itself. The use of cane or rush on furniture for decorative purposes only is distinctly a modern idea. Utility rather than beauty prompted the introduction of seats of rush.

Flag and cattail are very generally used for rush seating. Either in conjunction with the construction of a chair or stool will employ a new interesting medium in handcraft shops. And as is true of cane the resultant interest in the work at hand more than justifies the introduction as a craft medium.

Rush seating is done in a very simple weave, but various degrees of skill are required in working with the different materials employed in the weaving process.

Rush leaves average 6 to 8 feet in length and a strand or cord of rush consists of one to three leaves twisted together to produce the thickness desired in the cord.

Rush—and the term includes cattail and flag—is common in almost any locality in our northern states. It should be gathered when it is full grown and the stalk is still green. It is ready for cutting when the tips of the leaves begin to turn brown. This generally occurs about the middle of August. For convenience in handling, the leaves are tied in loose bundles and thoroughly dried in the shade or in a darkened room.

Projects in the Use of Rush

Rush Seat on Chair or Bench

Materials

Chair or bench frame
Rush leaves or
Hong Kong grass or
Fiber

Padding
Umber stain
Shellac

Tools

Scissors or knife
Mallet
Basin of water

Procedure—Preparation of Rush

Before making the strand, soak the rush leaves in water about 10 hours. The soaking can be hurried if warm water is used. The rush must be pliable and sufficiently soft to twist without cracking. A portion of the moisture can be retained by placing the rush in wet burlap until needed. Just before twisting the rush into strands it is often desirable to run the wet leaves through a clothes wringer to remove the excess water. Before weaving, cut off the butt ends of the leaves about a foot from the base. This section of the leaves is too stiff and coarse to weave properly. One leaf may be used or two leaves may be twisted together into a strand. One leaf makes a fine strand, two a medium, and three a coarse strand. A long tight twist is necessary to produce an even, smooth strand. Beginners will obtain better results with a strand made of single leaves since adding to a one-leaf strand is much simpler than adding to a strand composed of several parallel leaves. The secret of good work in rush is to keep this strand tightly wound and of uniform thickness. The strand is always twisted in the same direction and need not be twisted underneath the seat frame unless the individual worker so desires.

The Weaving Process

The start is the same for square or rectangular chairs, stools, or table tops. The corners are numbered 1, 2, 3, 4, from left to right around the stool, as shown in Fig. 118, where numbers are placed in circles at the corners of the frame. And if the rails are lettered *A* at the front, *B* at the left, *C* at the right, and *D* at the back (also shown in Fig. 118) it will facilitate the weaving process. With the frame ready and the rush in proper condition the weaving process may be started.

Step 1. In beginning, fasten one end of a twisted rush leaf at corner 1 by tacking or tying it along the underside of rail *B* for a few inches.

Carry the strand over rail *A* and around it and up through the open top. Right-angle this corner by carrying the strand over rail *B*, with the tacked end of the strand included, and around and up through the open top again.

Step 2. Carry the strand along rail *A* to corner 2 and over and around rail *C*, then up through the open top; right-angle this corner by carrying the strand over and around rail *A* and up through the open top again. Hold the strand firmly, and pull it straight, to prevent its kinking.

Step 3. Continuing to the right, carry the strand along rail *C* to corner 3 and go over and around rail *D* and up through the center; right-angle this corner by going over rail *C* and around and up through the center opening.

Step 4. Follow the frame to the next corner to the right, corner 4, and go over and around rail *B* and up through the open top. Right-angle this corner by carrying the strand over rail *D* and up through the center opening. Carry the strand to the starting corner 1 and repeat the process.

These four steps complete one round, and on the second and all succeeding rounds consider the strands already in place as part of the rail. As one length of rush runs out, lap the end of another length over it 2 or 3″ and continue twisting the strand in the same direction. If necessary the strand can be cut so that all joinings will occur underneath the frame, or will be covered by succeeding rows of rush strand. Keep the strands from overlapping at the corners. They should fit snugly where they go over the rails. To assure this, tap them into position with a mallet using a block of wood to protect the surface of the rush. This tapping should be done at frequent intervals or when several strands have been woven over each rail. It is desirable to have a uniform tension in the strand.

As the work progresses, pad the interior between the upper and lower layers of strands. The waste of the rush material may be used for padding. This padding should be done in a thorough manner, for it builds up the seat and prevents it from breaking down at the inner edges of the rails. The padding also prevents the seat from breaking down at the inner edges of the rails. The padding also prevents the seat from sagging through continued use. A slightly curved hardwood stick about 12″ long may be used to good advantage to do this work. Considerable force needs to be exerted in the padding and caution used to avoid breaking the strands.

Chapter X

HONG KONG GRASS AND ITS USES; PROJECTS

Hong Kong Grass Substituted for Rush in Chair Seating

In rush chair seating other materials may be used. Cane, raffia, and reed might be used but Hong Kong grass (Fig. 2A) is strongly recommended. Very few tools are required with this material. It is strong, and durable and is obtainable in continuous lengths. It is used extensively in industrial arts classes, recreational rooms, and by many others interested in handcrafts.

Hong Kong grass, a handmade Chinese product resembling rope, is twisted from sea grass, the twisting being done with the grass held under the water. This material is used largely for chair seating in place of genuine rush because a more desirable length is procurable, and the twist is uniformly made. Because it is handmade it varies slightly in diameter, but this adds to its appeal as a craft medium. A variety of solid colors as well as natural and colored strand combinations is obtainable in the 3/16″ diameter. It can be ordered in orange, red, green, blue, and brown in solid colors or these in combinations with the natural. This natural color is a pleasing yellow tan birch tone that harmonizes quite readily with most of the lighter shades and varieties of woods. It contrasts very pleasantly with the darker tones of old chairs and benches. The No. 3 or 3/16″ diameter Hong Kong grass is sold in hanks of 3 to 4 pounds, approximating 300 feet to the pound. One hank of No. 3, or about 3 pounds, should be sufficient for two radio bench seats of approximately 13″ x 19″, the size shown in Fig. 119.

Radio Bench with Hong Kong Grass or Fiber Seat

Materials

Hardwood bench pieces—to be assembled
Hong Kong grass or fiber rope
Sandpaper Nos. 0 and 00.

Tools

- Glue
- Fiber mallet
- Furniture clamps
- Stain, paint, or colored enamel
- Steel wool 000 or fine pumice stone
- Shellac
- Brushes
- Wax
- Waste cotton

Procedure—Preparation of radio bench for seat

Complete all sanding, glueing, clamping, and general finishing before undertaking the woven seat.

The seat section, legs, and spreader with cross bars must be sanded. Do the sanding by rubbing, with the grain of the wood, first with coarse sandpaper about No. 0, to remove the rougher surfaces, and then with a finer sandpaper, No. 00, to complete the smoothing process. Use a good wood glue to fill the holes, and after the legs are inserted in the top with the spreader and cross bars in position tap the joinings with a fiber mallet to insure a tight fit (Fig. 116). If a fiber mallet is not available a block of soft wood may be placed over the area to be tapped in order that the mallet blows will not mar the surface of the bench.

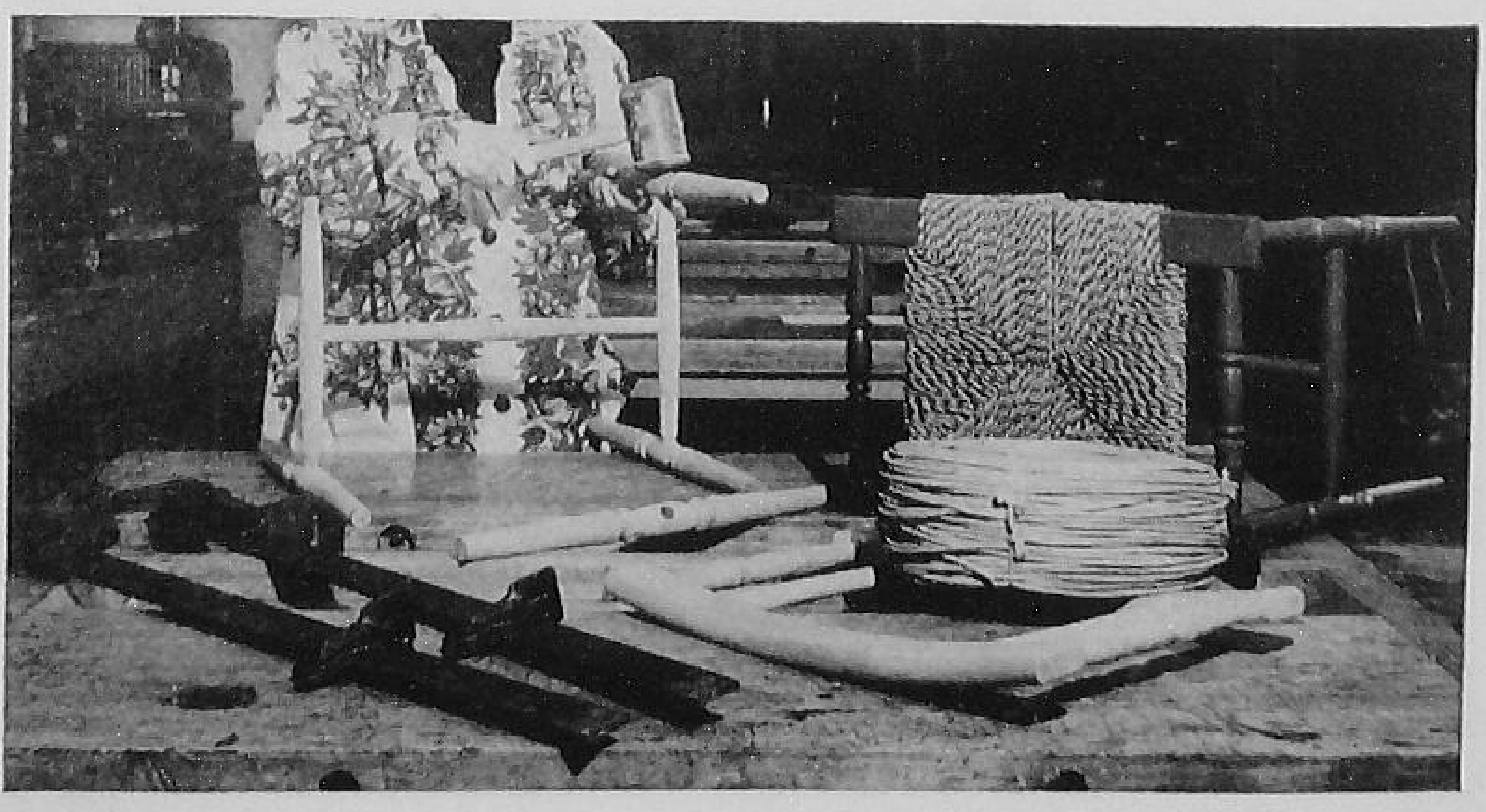


FIG. 116. Tap with fiber mallet to insure tight fit.

It is advisable to use furniture clamps to keep the tension on the glued sections until the glue has an opportunity to dry (Fig. 117). Use small blocks of soft wood directly under the clamps to prevent the legs of the radio bench from being marred by the metal clamp. Remove the excess glue by wiping around the joints with a cloth dipped in warm water. Inspect each joint and set the clamped bench on a level surface to check the proper alignment of parts. If all four legs do not rest on the level surface evenly a few sharp blows with the fiber mallet on the corners

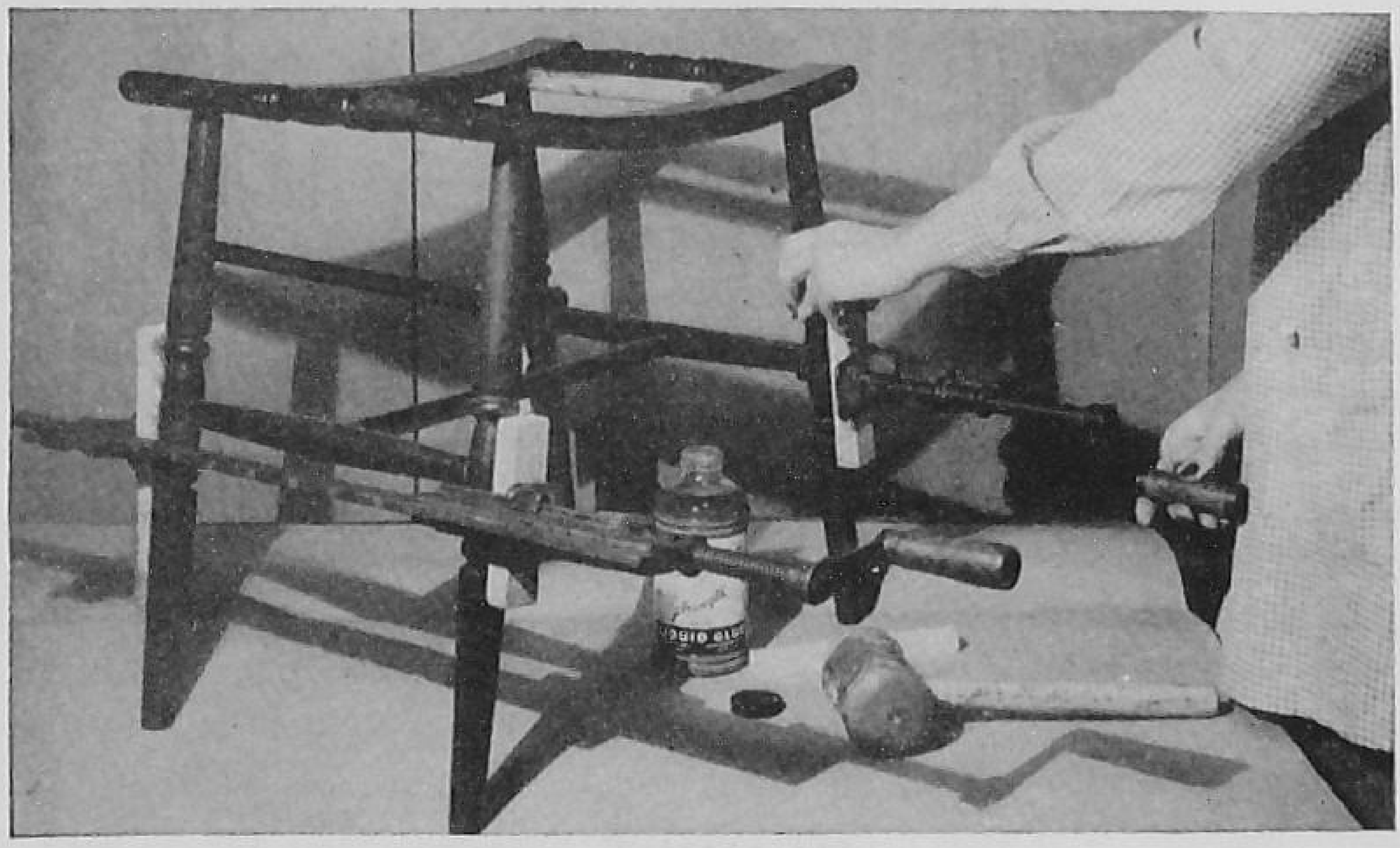


FIG. 117. Use furniture clamps until glue is dry.

above the longer appearing legs may help to obtain correct alignment. If a decided rocking or unevenness is still apparent after repeated tappings with the fiber mallet, additional adjustment, usually by sanding with very coarse sandpaper, may be necessary to insure a level, well-balanced radio bench.

Allow the glue to dry, at least overnight, before removing the clamps.

Before beginning the staining or painting, protect the top of the work bench or table with old newspapers or other covering. Brush the entire frame to remove any sanding dust before applying the stain or the priming coat of paint.

Staining. If a common oil stain such as maple, mahogany, or oak is desired it is applied to the smoother surfaces of the wood sections with

cotton waste. The amount of stain used depends on the depth of color desired. If the finish of the radio bench is to be matched to another article of furniture it is advisable to test the effect of the stain on the underside of the top rails to determine the strength of the stain to use to insure a correct matching of color. For a light finish the stain is used sparingly, and wiped off when the desired color is obtained. A darker finish requires a larger quantity of stain, which is rubbed into the wood surface quite energetically.

After the stain has dried, brush on in even strokes a coating of thin shellac or liquid filler. Allow this coating to dry thoroughly before beginning the weaving of the seat proper. If the surface is not as smooth as desired, it may be rubbed down with fine steel wool or fine pumice stone, and another coat of stain applied. A final coat of wax may be applied and rubbed to a high luster.

Painting. Thoroughly stir paint and thin with appropriate thinner to a consistency which will cover the surface easily and evenly. Dust the surface of the bench clean and wipe over with turpentine. Apply a priming coat of color dissolved in linseed oil, or equal parts of turpentine and flat white paint will serve as a primer. Allow several days for this primer coat to dry and then rub it smooth with fine steel wool. In all painting try to conceal the brush strokes. The best way to accomplish this is to brush first in one direction and then back over the same surface in the opposite direction.

After you have applied one coat of the finish color, allow it to dry for several days. Rub it smooth with steel wool and dust the surface to remove all specks of paint or dust. Apply a second coat and allow it to dry thoroughly. This will probably be your final coat. If additional coats seem necessary, the chances are your paint was not of the proper consistency to cover evenly. Rub down with fine steel wool or pumice stone between each coat to insure a smooth surface. Take care in the rubbing down process that the paint is not cut through at the sharp corners. As a final finish apply a coat of wax.

Enameling Unpainted Wood Surfaces. Apply the priming coat just as though you were painting the radio bench. Allow this to dry thoroughly. Rub down and apply one coat of gloss enamel. Allow this to dry. Rub down with pumice or fine steel wool. Cover with a final coat of enamel. If you prefer, you may omit the priming coat and apply four coats of enamel, allowing several days between coats, and rubbing each coat down with dry steel wool.

For a dull finished surface, rub down the final coat with a cloth dipped first in water and then in powdered pumice. There is also a special dull enamel sold commercially, which requires less rubbing down.

Lacquering. A coat of shellac must always be applied over any treated wood surface before brushing on a lacquer finish. Lacquer contains ingredients similar to those of other surface coating agents and will dissolve the undercoat if it is not protected with a shellac coating.

Weaving with Hong Kong Grass

Untie the bundle of Hong Kong grass and make it into smaller hanks. These should not be too large, or they will not fit through the opening as it grows smaller as the weaving progresses. It is somewhat easier to use a long hank of the grass than a ball (Fig. 119). The craftsman will find it less difficult to pass this long hank through the space between the frame and the side rail on the top of the bench. Soak these long hanks in water for about 10 minutes to insure pliability and ease in handling. If the Hong Kong grass is used in the dry state the strands will kink and poor tension may be the result. While the grass is soaking, mark the four

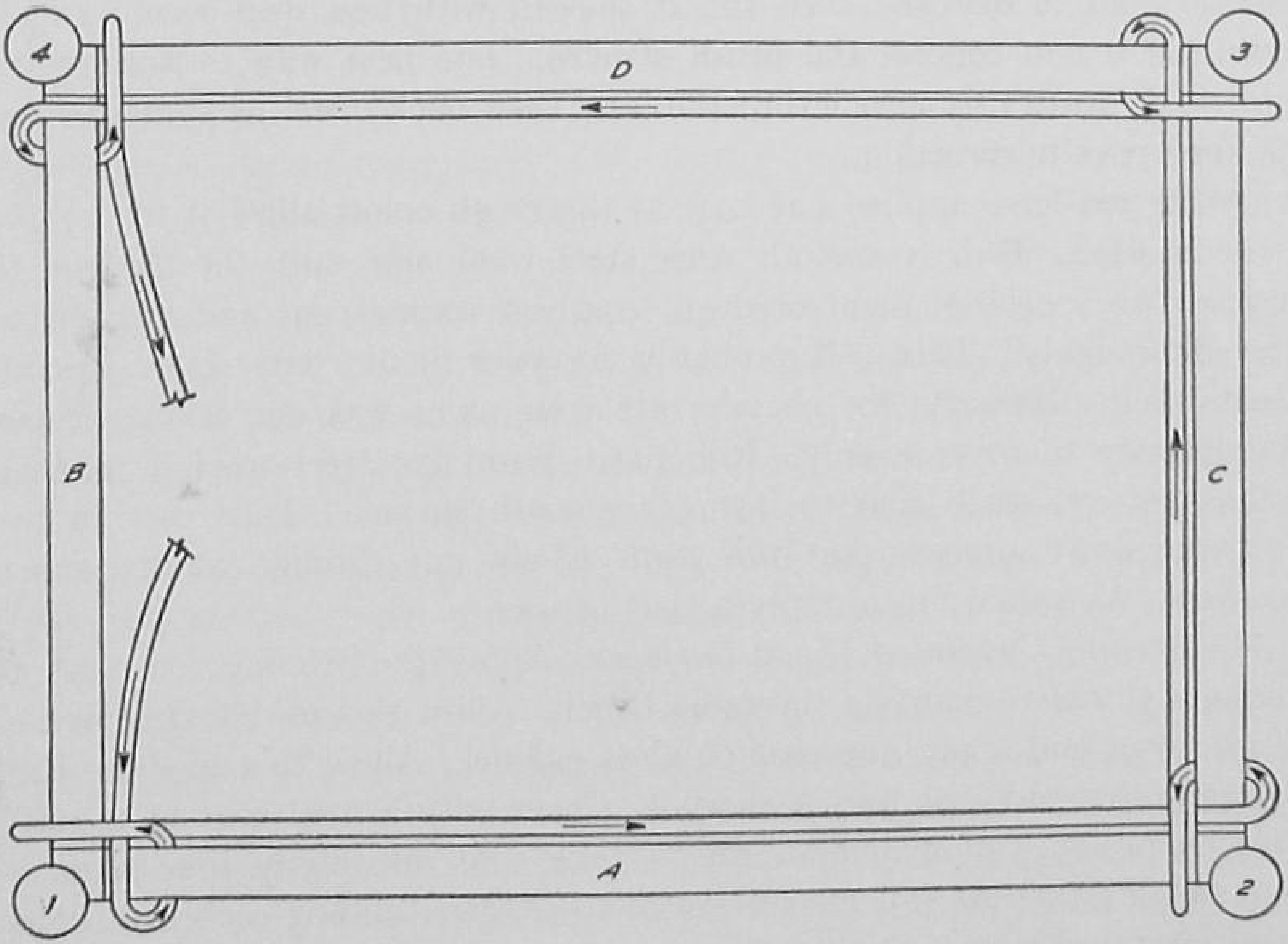


FIG. 118. The weaving process; number the corners as shown.

corners of the bench and letter the rails as explained on page 977 and shown in Fig. 118.

Start a strand of the grass at corner 1, tying the tab end along the inner side of rail *B* with cotton cord. This end may also be held in place with a small tack. Draw the strand over and around rail *A* and up through the open top of the bench, pulling the strand taut at the inner corner (Fig. 119); then right-angle the corner by carrying the strand over and around rail *B* and up through the open top again. This binds the loose end in place along the rail (Fig. 120) if it has not been previously tacked. Proceeding to corner 2 across the front of the frame and parallel to rail *A*, carry the grass strand over and around rail *C* and up through the open top again. Pull the strand taut and right-angle this corner by carrying strand over rail *A* and up through the open top once more. Pull the strand back across the frame opening to the top of rail *D* at corner 3 and carry over and around this rail and up through the open top; right-angle this corner by going over rail *C* and around and up through the open top. Follow the frame to the next corner (4) and go over and around rail *B* and up through the open top. Right-angle this corner by carrying the strand over rail *D* at the back, and up through the open top. Proceed to the starting corner (1) and carry the strand over rail *A* and around and up through the open top (Fig. 120); right-angle this corner by carrying the strand over rail *B* and around and up through the open top once again. The operations at all corners are identical, and they are repeated until the seat is completed.

It is advisable to make all splicings on the underside of the bench frame. Separate the Hong Kong grass strand into two ply about 3″ from the end of the strand and insert the new strand in this separation, for the depth of 3″. Separate the two ply of the new strand in the same manner so that the final end of the previous strand can be inserted in this separation. Tension on either strand tightens the splicing.

In weaving square seats the initial process is repeated at all corners until the opening is filled. In rectangular seats the spaces on the short rails will fill up before those on the long rails (Fig. 121).

Packing the Seat Frame. After the short rails have been filled with the grass strands the space between the top surface and the under strands must be packed to insure a smooth surface on the bench top and to protect the strands from undue strain at the point of crossing the edge of the frame rails. Do this by cutting corrugated paper in shapes to fit the areas to be packed and inserting two pieces in each section (Fig. 122).

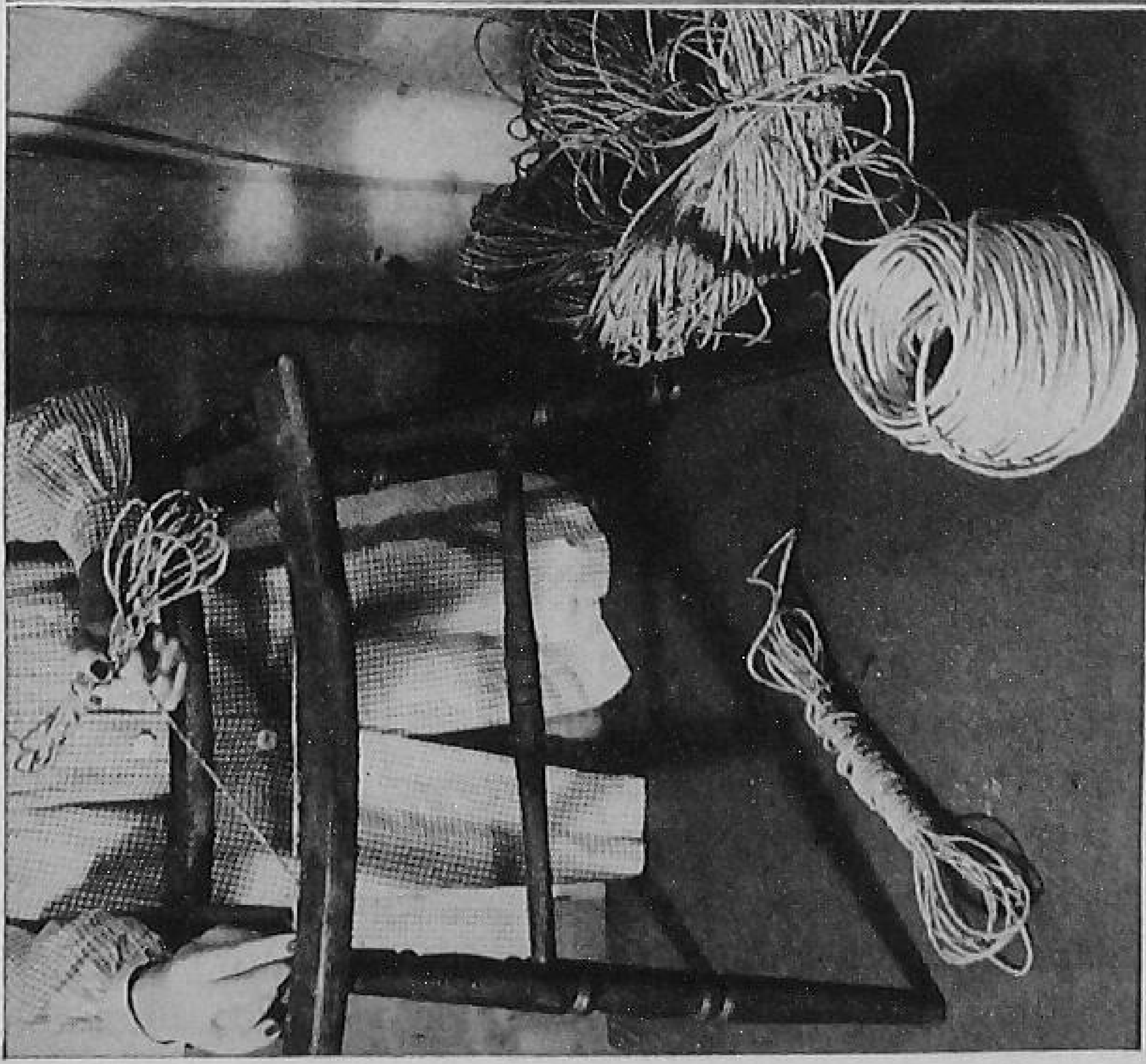


FIG. 119. Pull the strand taut at inner corner.

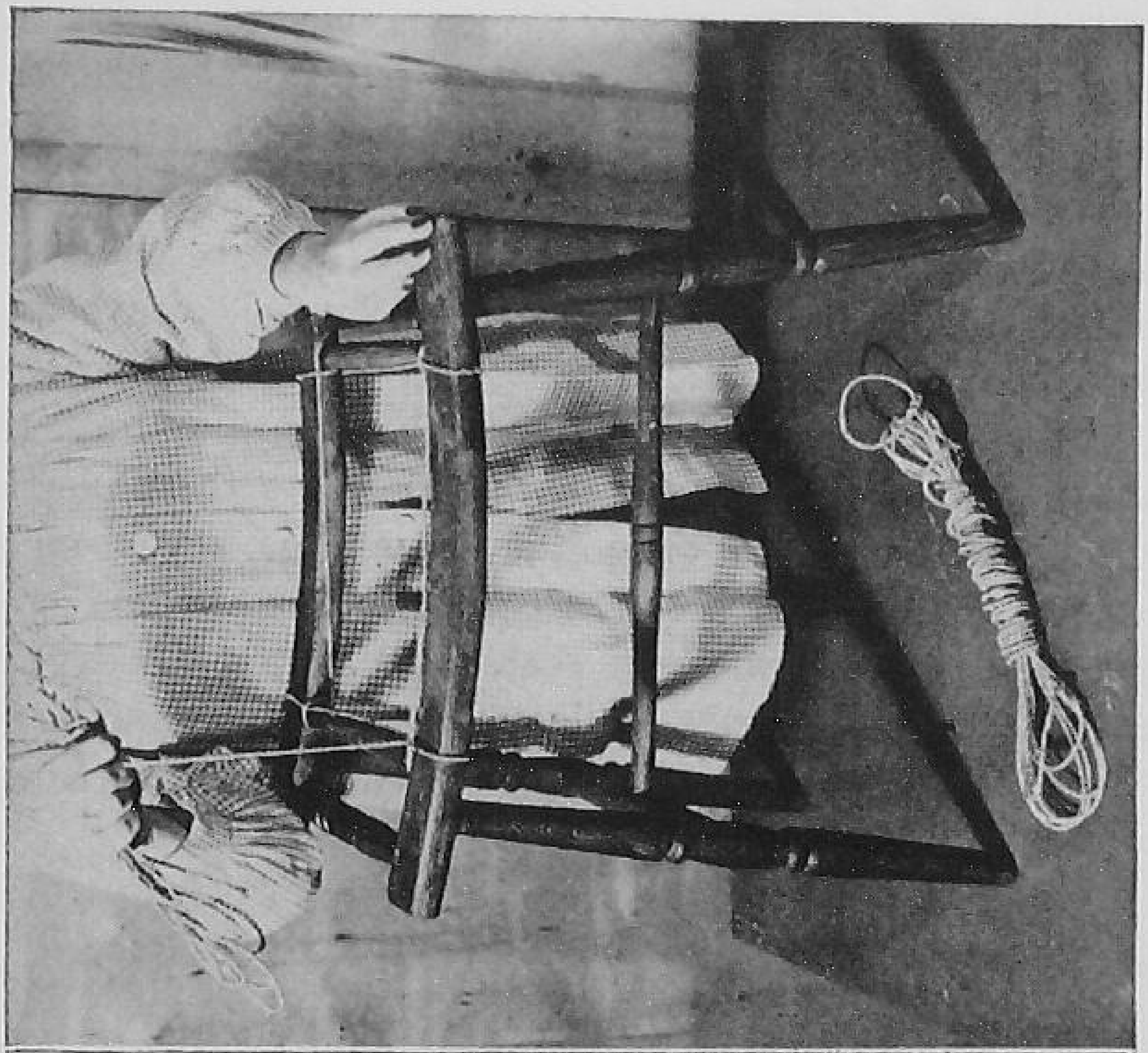


FIG. 120. Right-angle the corners.

Raffia or cotton waste or short ends of the grass may be used to stuff the space between these two layers of corrugated paper. The smoother and more uniform the packing is done in all four areas the better appearing seat top will result. Longer wear is also insured if the packing approximates the thickness of the rails, so that no abrupt ridge is apparent.

After the short rails have been completely covered, weave over and under the long rails into the center opening and over and under the opposite rail in a figure eight (Fig. 122). Repeat this operation until the long rails are covered. Pull the very end of the strand to the underside and fasten it with a half hitch knot, or loop it through one strand on each of the four sections, and then catch it under itself in one of these loops, and cut off the remainder. The completed seat, when thoroughly dry, may be given a coating of clear or orange shellac on both the top and the underneath surfaces to retain its sheen and prevent any moisture from being absorbed by the grass.

Irregular-Shaped Seat with Hong Kong Grass

Materials

A chair frame with loose seat section if possible
A hank of fine diameter Hong Kong grass
Heavy thread
Tacks
Gummed paper

Tools

A basin for soaking grass hanks
Sponge or small brush

Procedure—Preparation of Frame

The chair frame should be finished as desired before the seat weaving is begun. Fig. 123 shows the before and after appearance of a solid mahogany chair.

When the front rail is longer than the back, measure both rails between the corner blocks. Having found the difference, measure one half of it on the front rail from either post and mark this location. On the frame shown in Fig. 124 the back measured 8″ and the front, 13″, a difference of 5″, so that 2½″ was marked off from each corner block on the front rail. Heavy thread was wound around the two rails as shown in Fig. 124

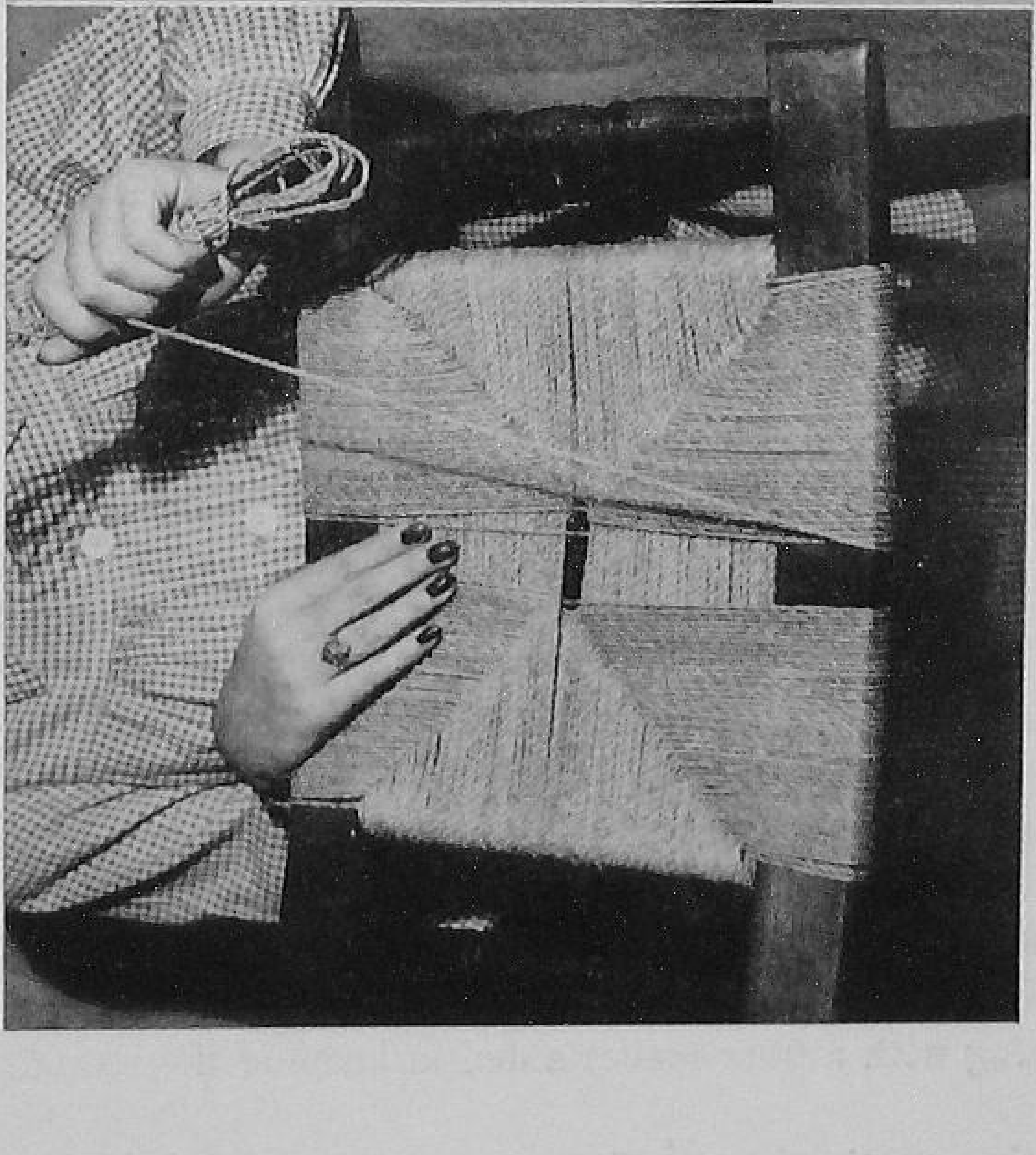


FIG. 121. Figure "8" loop used at center of rectangular seat.

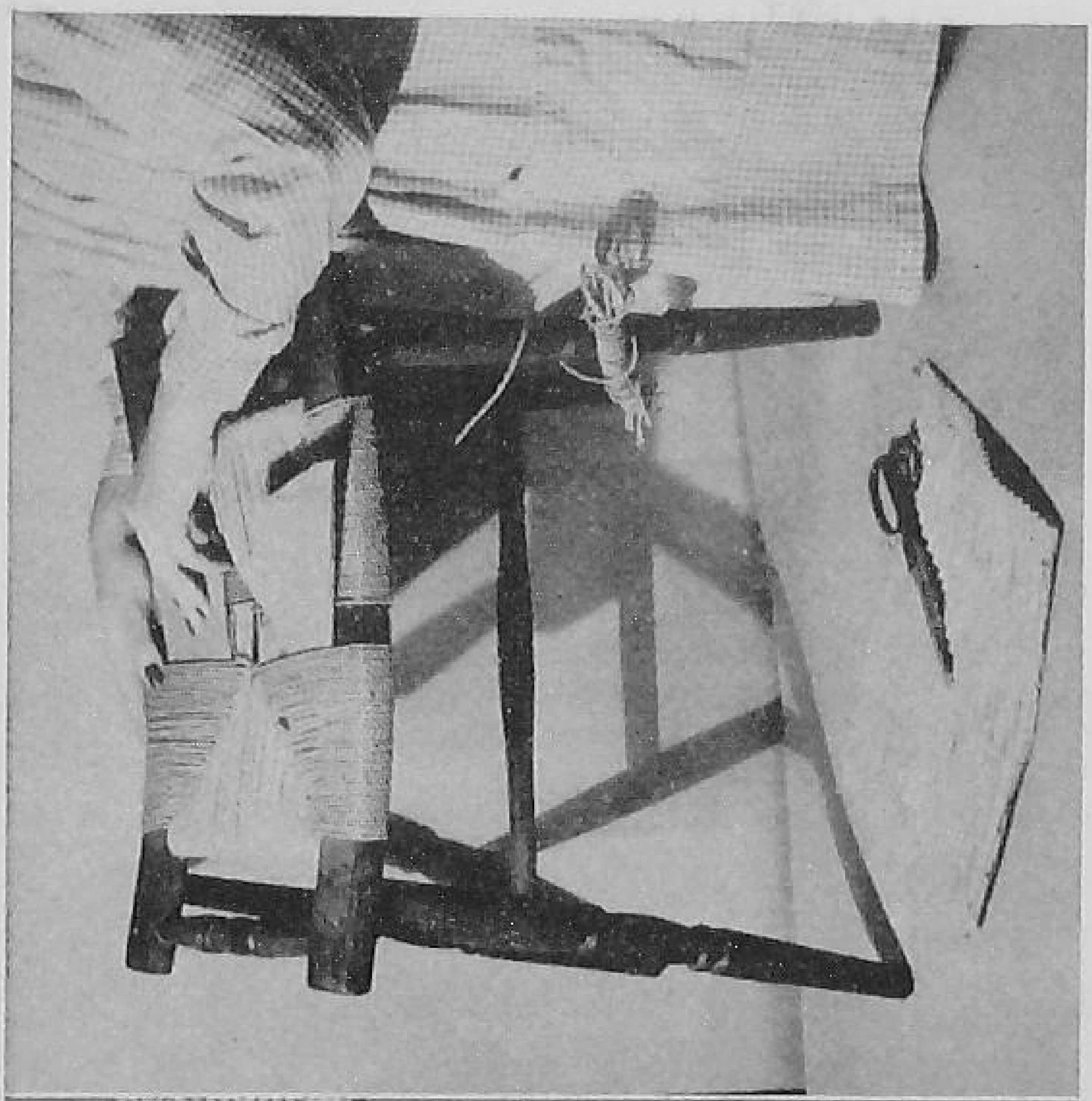


FIG. 122. Insert corrugated paper in sections as packing.

FIG. 123. Hong Kong grass seat—new and old.

to retain the equal lengths on the parallel rails as well as to show how many corner strands would have to be woven separately before a continuous strand would be carried from adjacent corners completely around the frame.

Weaving the Seat

Several small hanks of grass were made and soaked in water for five minutes. The end of a short length of grass was tacked on the inside of the frame at the front corner, as shown in Fig. 125, and carried around the corner and across the front to the opposite corner (Fig. 126). A right angle was completed at this corner (Fig. 127) and the strand pulled taut, and tacked in place on that side rail (Fig. 128). Succeeding strands were placed as close to the previous ones as possible without overlapping. A gentle tapping with a fiber mallet aided in keeping the strands in alignment.

The operation on the front rail was repeated until the extra space at

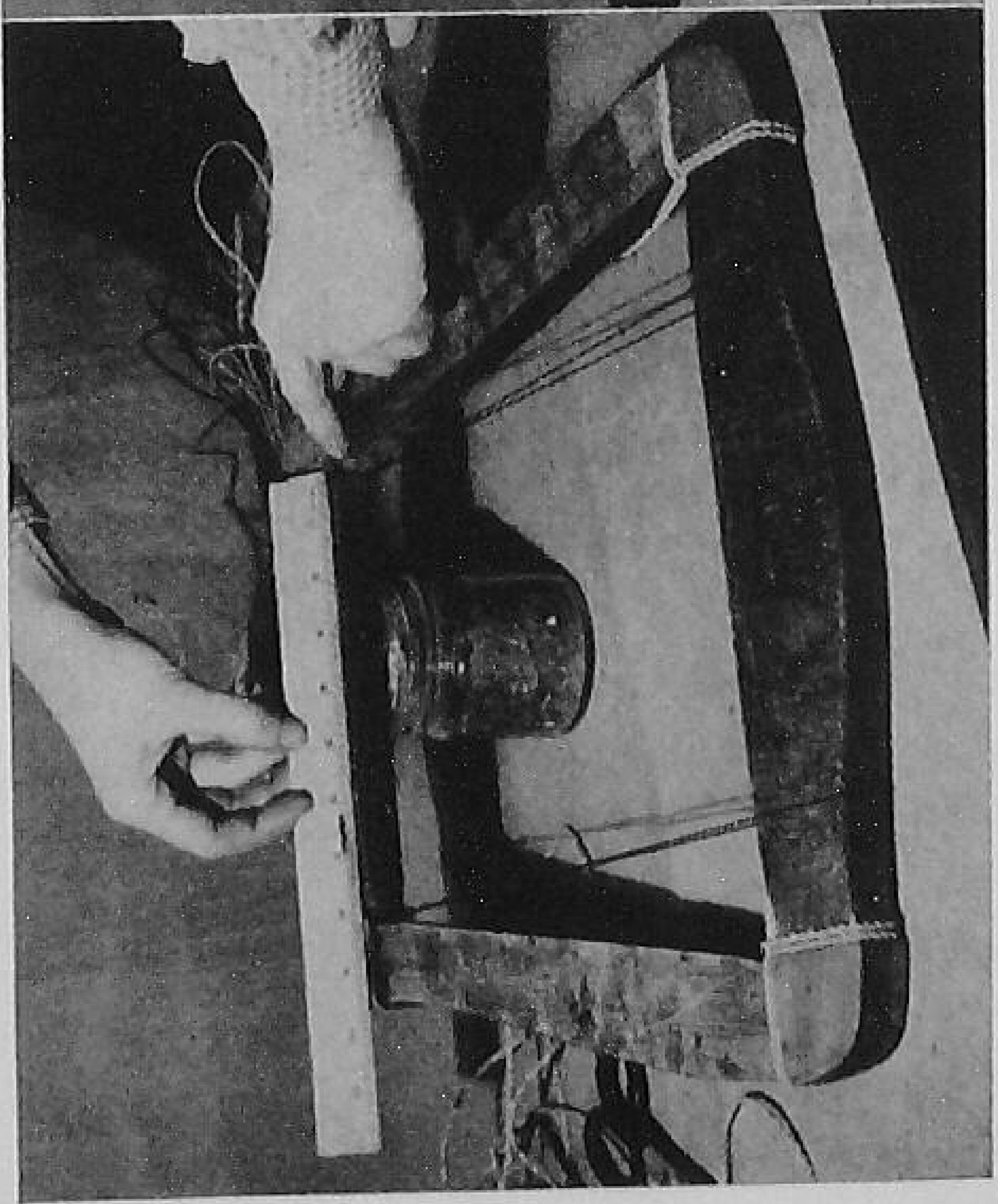


FIG. 124. When front rail is longer than back, measure the difference.

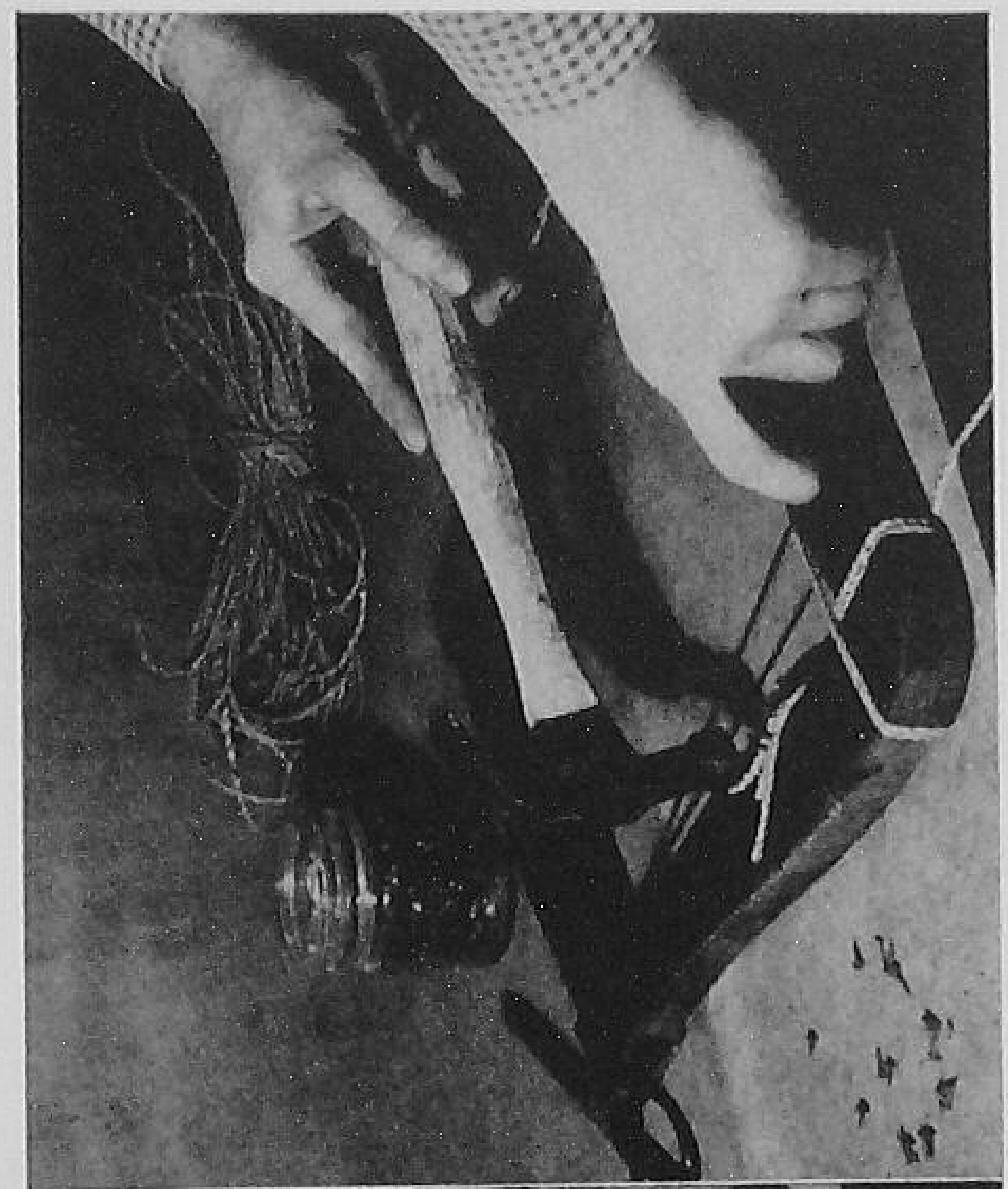


FIG. 125. Tack the short end of grass inside the frame.

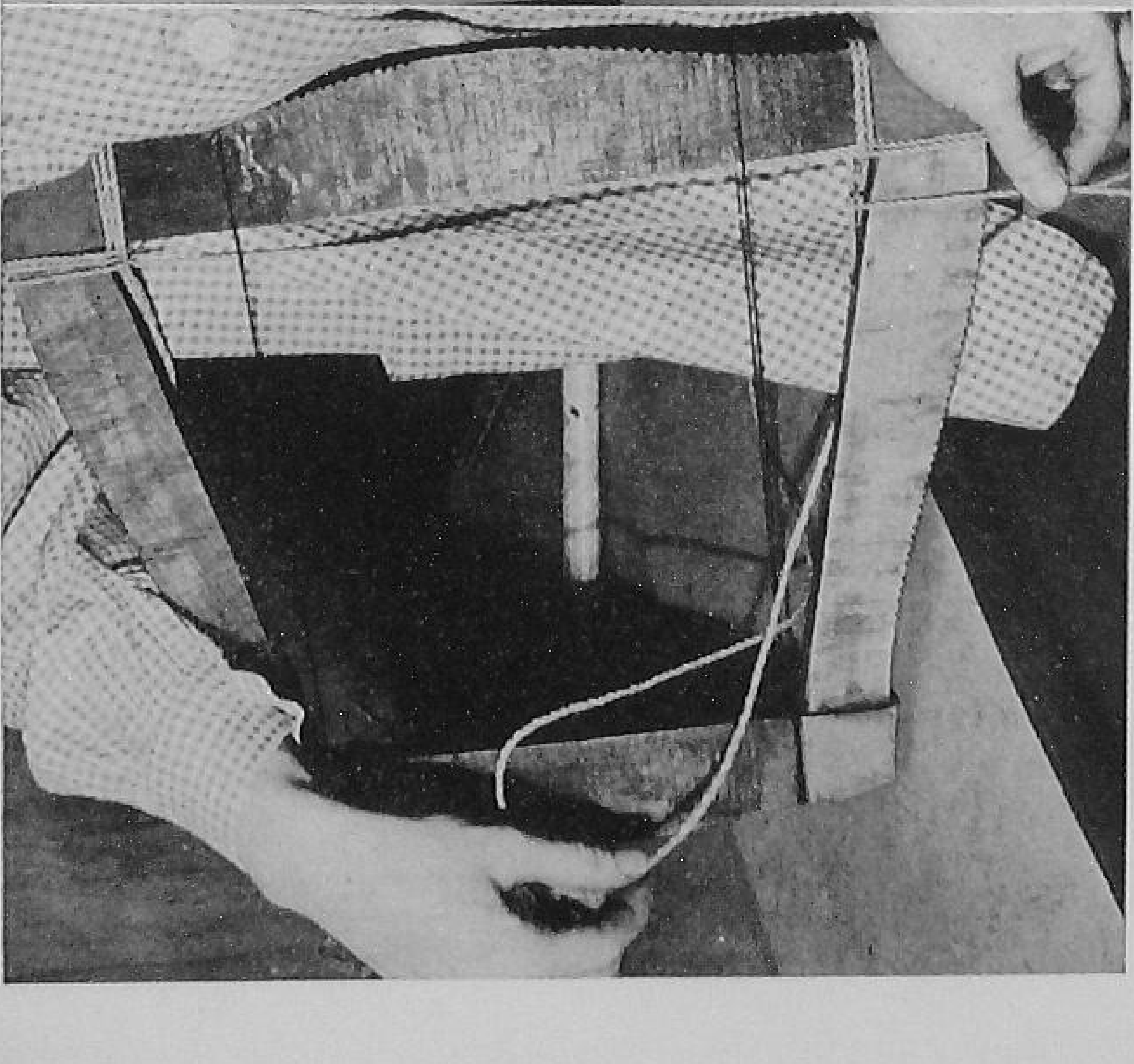


FIG. 126. Carry the strand around the corner and across the front to the opposite corner.

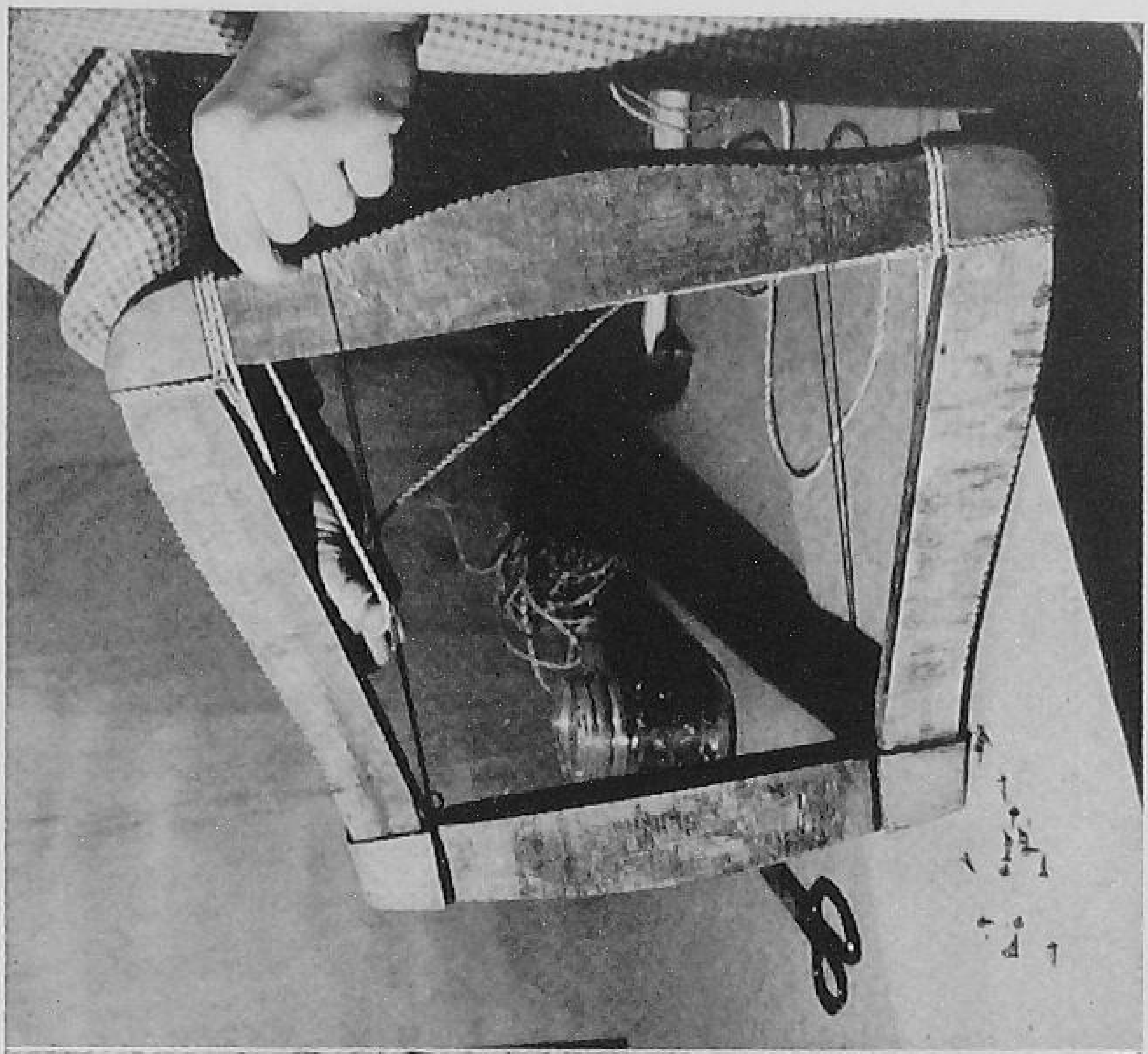


FIG. 127. A right angle is completed at the corner.

the two corners was filled in with sufficient strands to run parallel with the thread that was used to retain the equal spacing on the front and back rails.

Weaving proceeds as for a regular seat, strands already done being treated as part of the rail. The strands may be bound closer to the wood frame at the sides with cord or held in place with gummed paper (Fig. 129), while raffia packing is forced into the space between the top surface and the underneath strands. If a harder seat surface is desired, cardboard

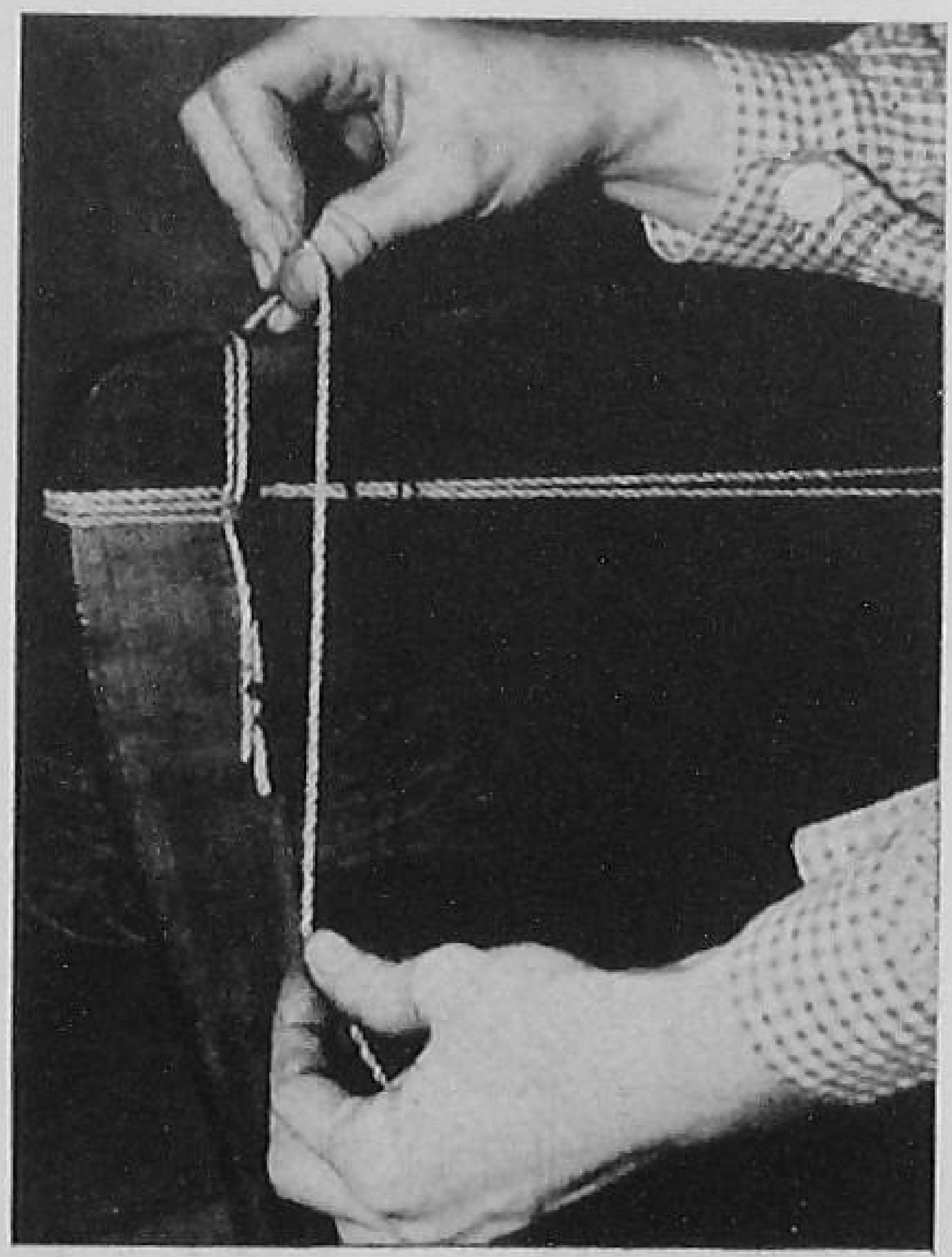


Fig. 128. Pull the strand taut and tack it in place.

sections cut to fit the areas to be packed may be inserted below the top strands and the remaining space packed with raffia strands. Gummed paper is used to hold these cardboard sections just over the edge of the wood rail so that no abrupt ridge is apparent (Fig. 130).

A wood wedge may be found to be very useful in forcing the packing out to the very corners of the frame (Fig. 131). Care should be taken in inserting the packing that no undue strain be put on any individual strands, or they may be stretched or even broken. As the weaving

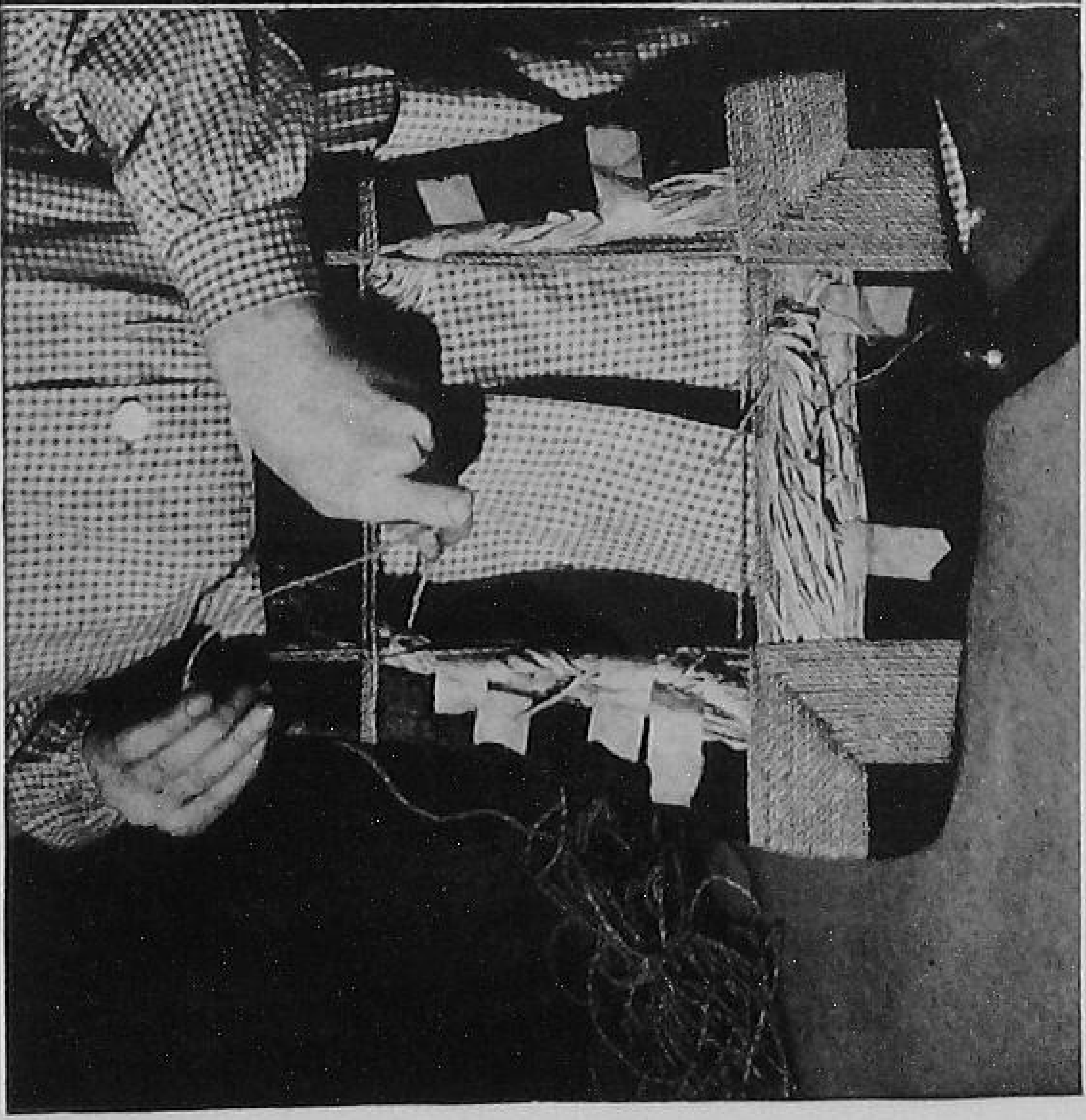


Fig. 129. The strand may be held in place with gummed paper.

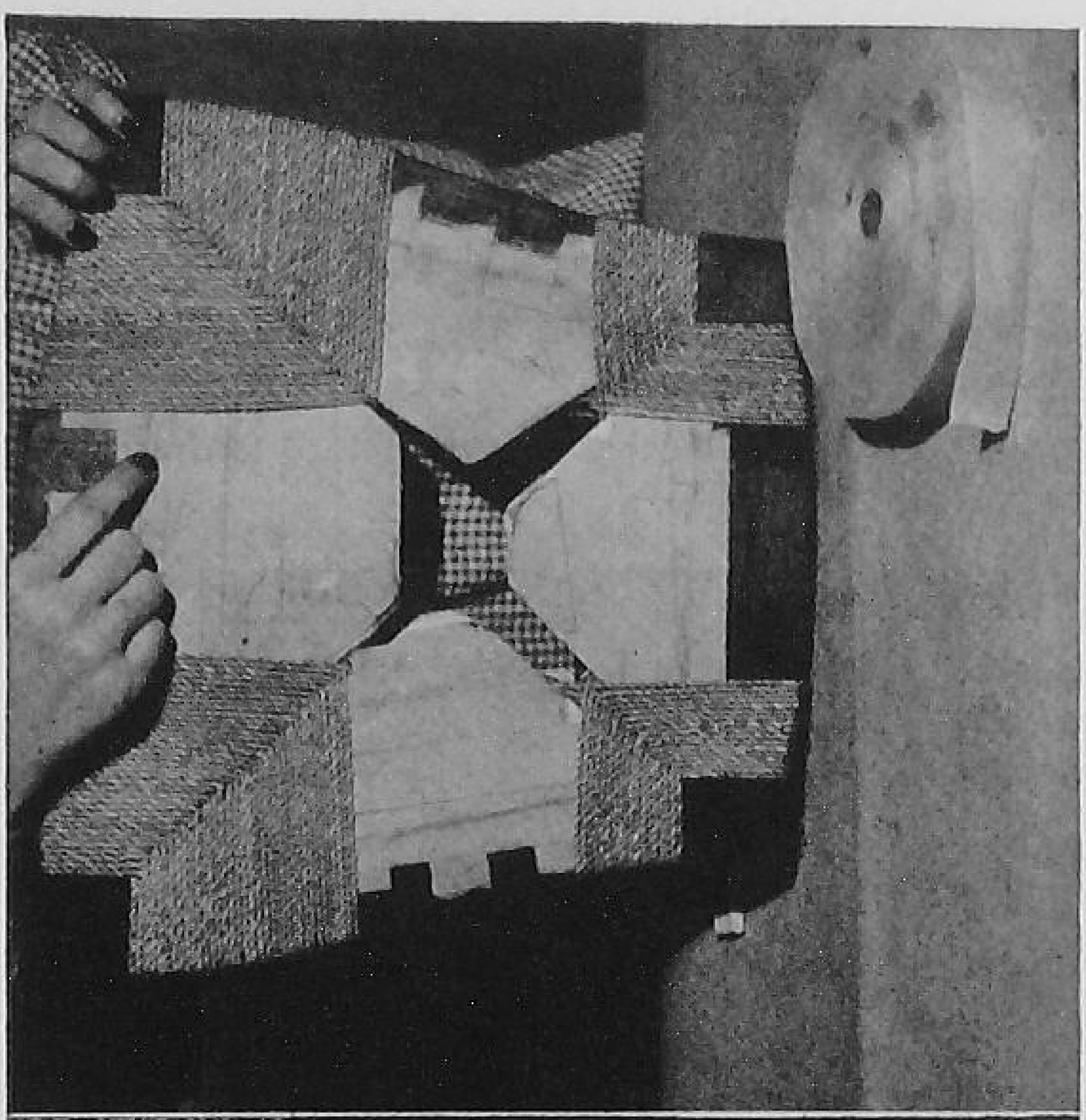


Fig. 130. Gummed paper is used to hold cardboard sections over the edge of the wood rail.

progresses the strands may need to be moistened with a sponge or small brush dipped in water, in order to keep uniform pliability.

If the side rails become filled before the front and back rails, as on chairs shown in Fig. 123, weave the remaining space by going *over* and *around* front rail, up through the center, *over* and *around* the back rail, and up through the center, repeating in the form of a figure 8 until space is filled (Fig. 121). If the fiber is used it will be necessary to flatten the

FIG. 131. A wood wedge is useful in forcing the packing to the corners of the frame.

strands where they cross in the center in order to fill in evenly. This may be done by tapping with a small mallet or hammer. The secret of good work with fiber lies in keeping the strands pushed together tightly as they go around the side rails. This may be done with a blunt screwdriver or hammer. Be very careful to keep a straight line in the diagonal corners to prevent overlapping of the strands.

If rush or grass seats are left before completion an ordinary spring clothespin is practical to fasten the free end to the seat, thus holding it

tightly in place. Cover the seat with a wet cloth when leaving for overnight.

When the seat rails are completely filled the strand end is carried to the underside and caught in a half hitch or loop around another strand and cut off.

Finishing. A coat of thin shellac may be applied to both the top surface and the underneath side of the woven seat to prevent any moisture from penetrating the grass or fiber. The natural color of the Hong Kong grass is a pleasing combination with the darker wood chair frames. But the woven seat may be stained to match any of the wood colors by testing the strength of the stain on the underside of the seat before applying it to the top surface.

Navajo Knot Seat on Chair Frame

Materials

A chair frame with round or fairly narrow rails
Two tone Hong Kong grass—1 hank

Tools

Basin for soaking grass hanks
Sponge or small brush

Procedure

Finish the surface of the frame of the chair or footstool before beginning the weaving of the seat.

Use a small hank of soaked grass, as it is somewhat easier to get a good tension with a hank than with a ball of the grass. Then, too, when the space between the rails gets smaller and smaller as the weaving progresses a longer hank can be pulled through much more easily than a ball.

Hold one end of the strand over the back rail and carry the strand to the front rail, around it, and up on the right side of the strand. (Fig 141). Then carry the hank across the strand and around under the rail again; then up through the loop (Fig. 142) and back toward the back rail pulling the Navajo knot as tight against the front rail as possible, and the strand as taut as seems necessary to prevent any sagging downward of the cross strands.

Repeat the knot at the back rail and continue first on the front rail and then on the back, until both rails are covered. Since the back rail is shorter than the front on the chair used as a model in Fig. 141, force the knots as close together with a wooden wedge as they can be pressed on the back rail.

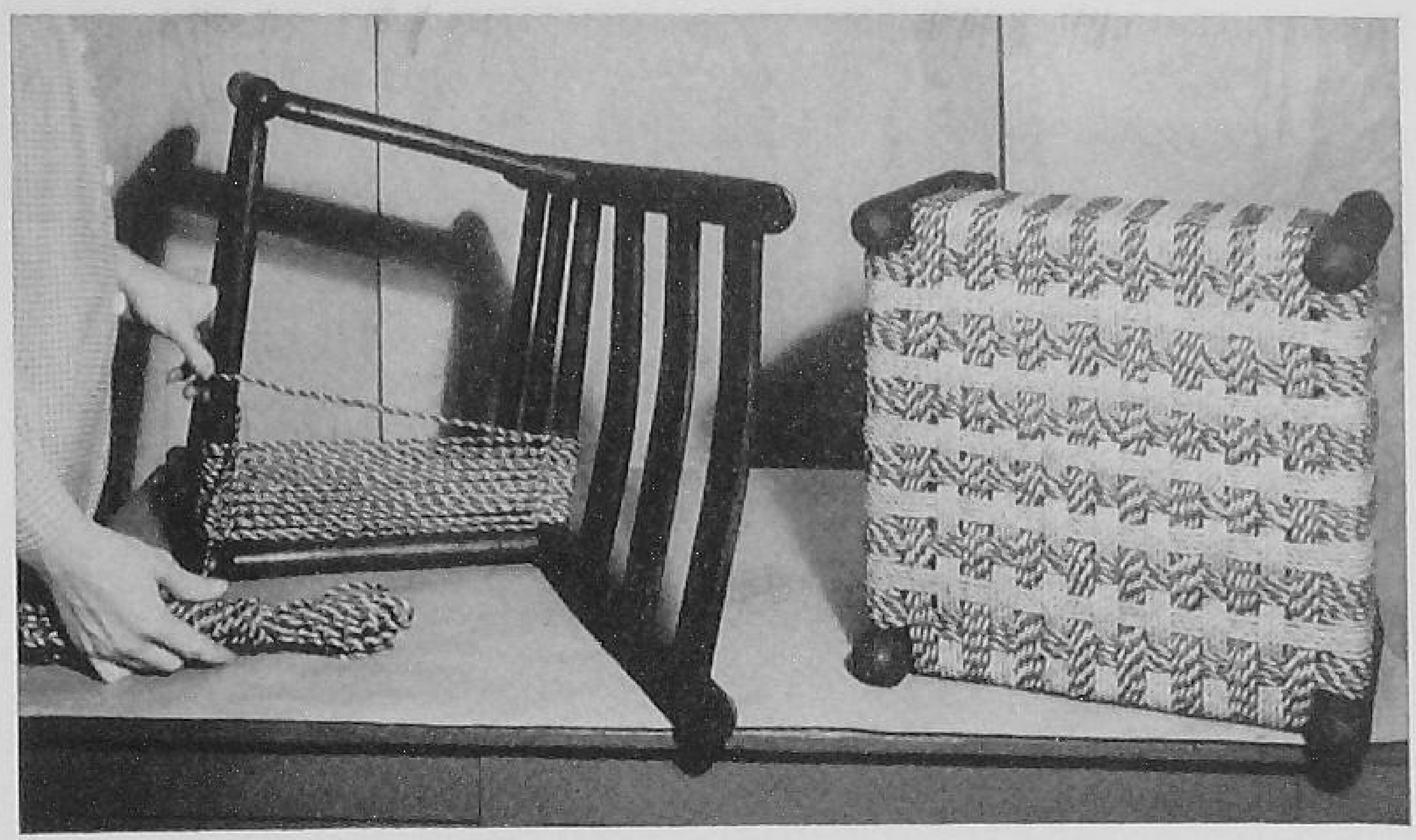


FIG. 141. Bring end of strand over front rail.

When the back and front rails are filled, continue the knotting from one side rail to the other until both those rails are covered.

A checkerboard pattern or chevron design may be used in interweaving the strands from the side rails. The four strands made in forming two knots on the parallel side rails may go under the first four strands made in forming two knots on the front and back rails and over the next set of

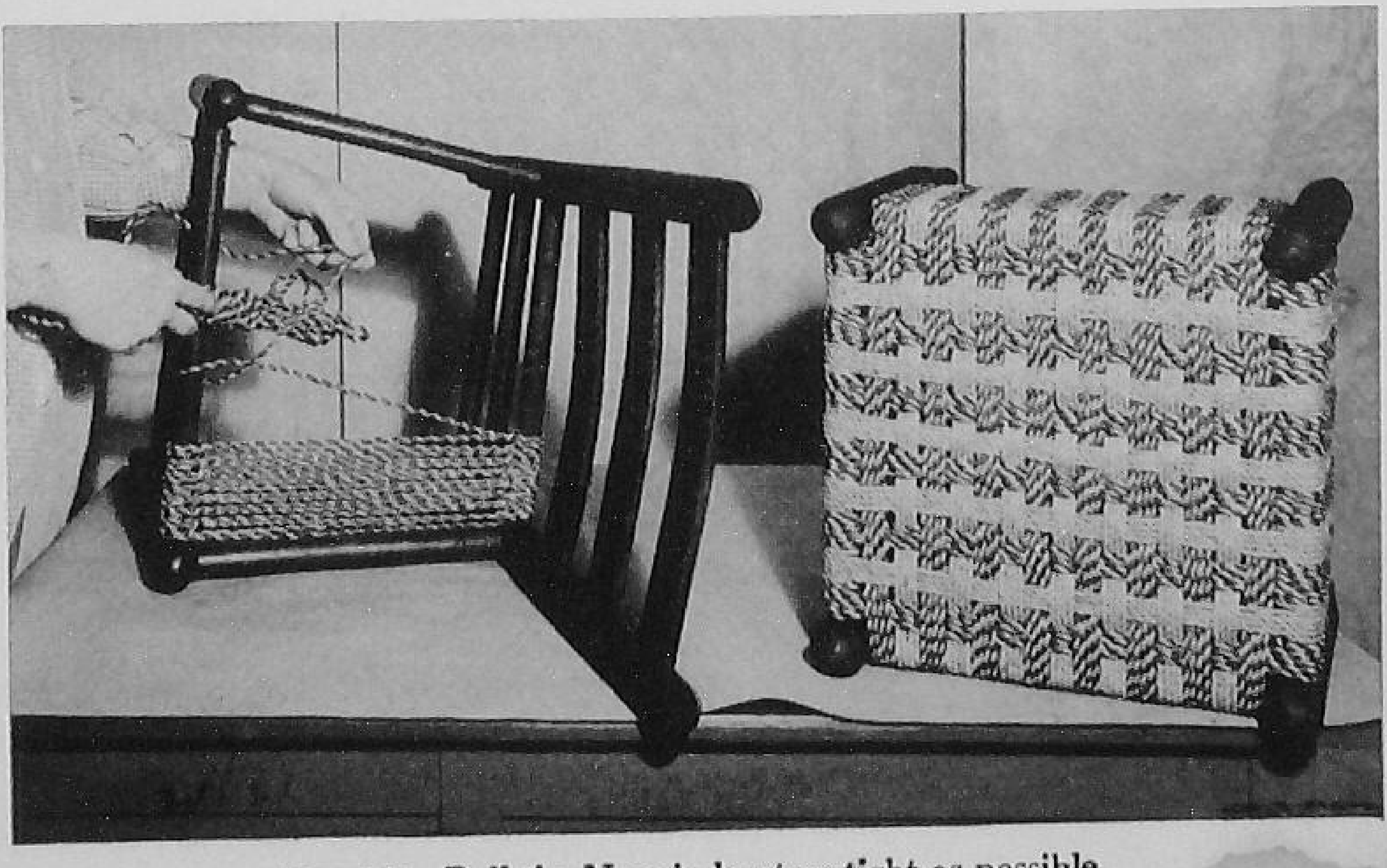


FIG. 142. Pull the Navajo knot as tight as possible.

four strands made in forming the next two knots on the front and back rails. A wooden wedge will be needed to open the shed to allow the strands to be interlaced. Continue this weaving of four strands over four and under the next four until the chair seat rails are completely covered. Catch the end under the interweaving and cut it off.

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